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THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

· MAY · 1916 ·

THE JOURNAL
OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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VOLUME 38 — MAY, 1916 — NUMBER 5

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To Junior and Student Members

JUNE 30, 1916, is the last day for submitting papers for consideration by the Committees of Award for the Cash Prize of $50.00 and Engraved Certificate, available for the best paper of the year by a Junior Member, and for the four Cash Prizes of $25.00 each, and Engraved Certificate, available for the four best papers of the year by members of Student Branches of the Society.

There is still ample time for those who have not yet entered this competition to prepare their contributions and submit them by the above date.

Select a subject of practical value and treat it in a simple, correct, clear and forcible manner. A contribution might well be:

A description of a new mechanical invention or piece of engineering apparatus.

An account of some original work in the laboratory, shop or class-room.

A description of a new and novel piece of mechanical construction.

An explanation of the merits of a piece of construction.

A description of a novel modification to an existing plant.

An explanation of plans or methods of proposed engineering work.

A summary of present practice in a given mechanical field.

An argument for or against a particular mechanical apparatus or process.

An argument for or against a particular type of mechanical construction.

An argument for or against the use of certain materials.

An argument for or against the employment of a particular system of management.

A record of the costs of a certain piece of work.

Papers must be the *bona fide* production of the contributor and must not have been previously made public.

All committees like to consider papers which have been gotten up in good shape—preferably typewritten in doublespacing on sheets of uniform size, say 8½ x 11 in., with illustrations neatly drawn and tabular matter clearly arranged.

A statement regarding these prizes is made on page XXVI of the 1916 Year Book, and the Rules of Award are given on Pages 441 and 442 of the same volume.

The awards will be announced at the Annual Meeting, December, 1916, and will also be published in THE JOURNAL.

COMING MEETINGS OF THE SOCIETY

May 3, *Providence, R. I.* Engineers' Dinner. Frank B. Gilbreth, Toastmaster. The speakers will include His Honor, Joseph H. Gainer, Mayor of Providence, W. H. P. Faunce, President of Brown University, Calvin W. Rice, Secretary of The American Society of Mechanical Engineers, David B. Rushmore, Representative of the American Institute of Electrical Engineers. Henry A. Wise Wood, President of the Wood Newspaper Machinery Corporation and President of the American Society of Aeronautic Engineers, will speak on The Wisdom and Ethics of Preparedness.

May 9, *New York, N. Y.* Subject: Report upon Efficiency Tests of a 30,000 kw. Cross Compound Steam Turbine, by H. G. Stott and W. S. Finley, Jr.

May 15, *Chicago, Ill.* Subject: The Use of Powdered Coal as Fuel, by Joseph Harrington, Advisory Combustion Engineer, Chicago, Ill.

May, Boston, Mass. Final Meeting of the Season. Date and subject to be announced.

May 23, *Philadelphia, Pa.* Subject: Naval Engineering, or a kindred subject, by a representative of the Department of Steam Engineering of the Navy.

ANNUAL MEETING, DECEMBER, 1916

The Annual Meeting of the Society will be held in New York, December 5-8, 1916. *All papers for this meeting* should be sent to the Secretary not later than September 20, and those who contemplate contributing papers should notify the Secretary in advance of this date if possible. On account of the time required for all of the members of the Committee on Meetings to read the papers submitted, and because of the insistence of the membership that the accepted papers be printed and distributed well in advance of the meeting, any papers received after the date mentioned are liable to be held over for a later meeting. In view of the fact that the date announced is immediately following the summer season, which is the usual vacation period, the members are urged to prepare papers during the coming spring so far as possible, and to submit them early in the summer.

PROCEEDINGS SECTION

THE papers selected for this issue are from contributions by Local Committees, and it is a striking commentary on the national scope of our organization that they have been read at meetings in the widely separated states of Louisiana, California, Massachusetts, Minnesota and Missouri. The first two papers deal with the reclamation of the lowlands of the South and Southwest; one of these was presented at the Spring Meeting. Papers on a new development in safety valve design, portland cement chemistry and manufacture, and on specifications and contracts conclude the section.

THE EVOLUTION OF LOW-LIFT PUMPING PLANTS IN THE GULF COAST COUNTRY

BY W. B. GREGORY, NEW ORLEANS, LA.

Member of the Society

SINCE the time, ages ago, when an arm of the Gulf of Mexico extended as far north as Cairo, Illinois, the mighty Mississippi and its tributaries have been building up the alluvial deposits of the delta through which it flows. Wells drilled at various points in the alluvial country have shown that the depth of the deposits is more than 3000 ft. in some instances. The deposit is very fertile as it was formed from the best of surface soil from the various states above. Usually the surface of the wet prairies, when first reclaimed, is covered with muck or humus, the decayed vegetation of hundreds of years, to a depth varying from a few inches to several feet. This material is rich in nitrogen and is a valuable fertilizer. The Southern half of Louisiana contains much wet prairie land, the Eastern portion of which is alluvial, while the Western part and the wet lands of the coast of Texas are the lower and poorly drained portions of the coastal plain, elevated from the bed of the Gulf during some mighty upheaval in a geological epoch long ago. This soil is usually a silt loam with an impervious clay subsoil. It has been found especially well adapted to the cultivation of rice.

As the alluvial soil was deposited by the rivers, the highest land is found near the banks and there is a gradual slope from the rivers and bayous back to the swamp. Previous to the last decade the only reclaimed agricultural lands in Louisiana were in the rear of sugar plantations. The early planters cultivated the narrow strip of land along the streams, which could be drained by gravity. The width varied greatly, but usually the distance from the levees back to the swamp was from half a mile to two miles. The cultivation of sugar cane created a demand for more land and the demand was met by continuing the plantations in the direction of the swamps and removing the water by means of pumps from lands too low to drain by gravity.

About ten years ago a movement was started by Edward Wisner to reclaim the wet prairie lands lying at or near Gulf level. The work is now being carried out on an extensive scale. More than a quarter of a million acres of agricultural lands have been reclaimed or are at present in the process of reclamation in the State of Louisiana. These lands in their natural state produce nothing more valuable than water grass, but when reclaimed they are classed with the most fertile and productive to be found in the world.

In this section, it was only natural and normal that pumps used successfully in drainage work would be employed in the irrigation of rice when that industry developed. Often the lift for irrigation did not exceed that in common use in drainage plants and especially in relift irrigation pumping plants. Drainage by pumps was an accomplished fact before the irrigation of rice assumed proportions that made the industry of economic importance. Later on drainage received a fresh impetus from the reclamation of the wet prairie lands while the rice industry had attained maturity. The story of pumping plants in this section at times must therefore deal with drainage and at times with irrigation.

New Orleans was founded by Bienville in 1718. The site on a narrow strip of land with a swamp in the rear, was

FIG. 1 MISSISSIPPI RIVER LEVEE IN LOUISIANA

chosen because on one side Bayou St. John gave an opportunity for transportation, with the small craft of that day, from the rear of the city into Lake Pontchartrain, and out through the Rigolets to the Mississippi Coast; while on the other side of the river, opposite the city, Bayou Barrataria offered transportation facilities to the South through a network of bayous to the Gulf. By both these routes the city could be approached without stemming the current of the river. One of the first acts of the early colonists was to build a small levee in front of the city. The height has been raised from time to time because of increased flood heights, due largely to the confining of the upper river between levees instead of allowing it to overflow large areas.

In the city of New Orleans a large portion of the surface is at or near Gulf level and an artificial water level must be maintained several feet below that of Lake Pontchartrain, which opens into the Gulf and normally is at the same elevation. The city is not only protected from the Mississippi on the river front by a levee, but is entirely surrounded by levees. There is one near the shores of Lake Pontchartrain, while

Presented at the Spring Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New Orleans, La., April 1916. Pamphlet copies without discussion may be obtained; price 25 cents to members, 50 cents to non-members

protection levees extend from the river to the lake both above and below the city to guard against the possible danger due to crevasses in the levees of the river above or below the city. All the run-off must therefore be pumped and some of the water is elevated two or three times before it is finally discharged into Lake Pontchartrain or through Bayou Bienvenu into Lake Borgne.

The drainage of agricultural lands is quite a different problem from the drainage of a city. While it is undesirable to have ditches and canals overflow their banks on farm lands, because of the possible injury to crops, flooding at rare intervals, provided the water may be removed before serious losses result, may be justified as good engineering; while in a city all floods are to be prevented in so far as possible. In any

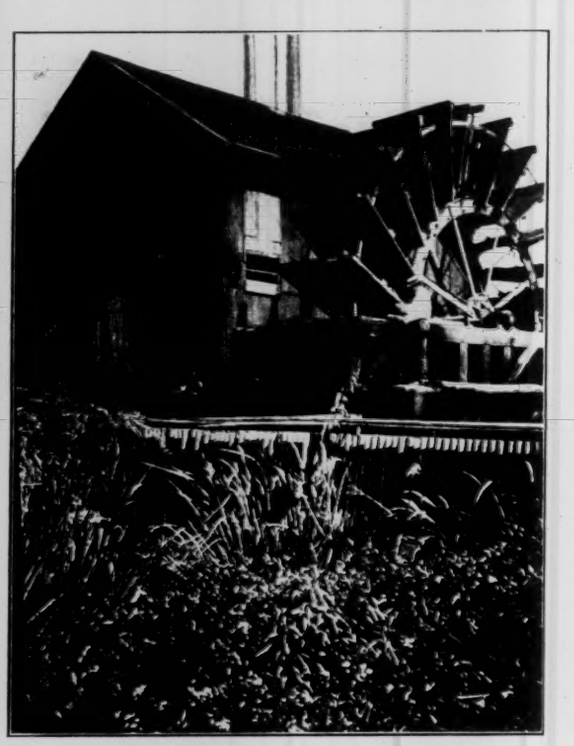

FIG. 2 DRAINAGE WHEEL, SOUTHSIDE PLANTING COMPANY

case, the first cost of the works required to eliminate the danger, the interest on the investment, and the depreciation and the upkeep are to be considered and balanced against the possible damage from floods and the damage which is dependent on the average period between the occurrence of unusual storms.

The capacity of pumping plants varies with many factors among which may be mentioned: (*a*) rate and distribution of rainfall; (*b*) general design of collecting ditches and canals, including their storage capacity, cross section, slope and arrangement; (*c*) nature of the territory drained. The run-off will be much greater for a city with paved streets and closely built structures than on agricultural lands. Again the condition of agricultural lands or the kind of crop produced will affect the run-off.

The rainfall map of the United States shows that there is an area extending from the North shore of Lake Pontchartrain, east along the coast of the Gulf of Mexico, and far into Florida, where the rainfall is 60 in. or more per annum. West of New Orleans the rainfall decreases to 50 in. per annum near the Sabine River, the boundary line between Louisiana and Texas, and falls to 30 in. in the eastern half of Texas. But the rate at which precipitation takes place has an important bearing on the capacity of the pumps that are required to remove the run-off from the nearly level lands. A few examples of unusual storms will make clear that the problem is one not shared by the other parts of this country. On April 25, 1907, 7 in. of rain fell in 5 hours and 8.59 in. in 12 hours. On March 22 and 23, 1912, unusual rainfall occurred. The records kept by the Sewerage and Water Board of New Orleans showed the following rates of precipation:

5 minutes	.68 in.
8 minutes	1.09 in.
10 minutes	1.38 in.
15 minutes	1.69 in.
20 minutes	2.00 in.
1 hour	2.48 in.
2 hours	4.66 in.
$2^1/_4$ hours	5.07 in.
Total, 2 days	7.23 in.

The United States Weather Bureau records at the New Orleans station show that there have been 57 storms in the past 26 years during which the precipitation in 24 hours exceeded 3 in. These storms are classified as to their intensity as follows:

57 rains exceeding 3 in. in 24 hours.
25 rains exceeding 4 in. in 24 hours.
10 rains exceeding 5 in. in 24 hours.
5 rains exceeding 6 in. in 24 hours.
3 rains exceeding 7 in. in 24 hours.
3 rains exceeding 8 in. in 24 hours.
0 rains exceeding 9 in. in 24 hours.

The maximum rainfall in 24 consecutive hours recorded at New Orleans was 9.22 in., April 7 and 8, 1883. The normal rainfall, which is typical of that for a large portion of the State and especially for the reclaimed lands to the South and Southwest of New Orleans, is remarkably well distributed and the growing season of June, July and August receives the maximum rainfall.

Run-off is usually stated in terms of a drainage coefficient or the depth in inches of water, if spread over the entire area to be drained, removed in 24 hours. In the Upper Mississippi valley and along the Illinois River, a drainage coefficient of $^1/_4$ in. has been found satisfactory. In the later plants, however, there has been a tendency towards greater capacity and pumping plants recently installed have been designed for a drainage coefficient of $^3/_{10}$ in.

In Louisiana, it is only in recent years that a drainage coefficient has been worked out. The older pumping plants varied widely in capacity according to the ideas of the parties who installed the machinery. In its 1909 Drainage Investigations, the U. S. Department of Agriculture started some work in Louisiana along the following lines:

(1) To study the soil, climate, and the natural condition with special reference to the drainage problems encountered and the value of the land for agricultural purposes when successfully drained.

(2) To collect such technical data and to examine such details of present practice as will afford information of value to land owners and especially to engineers interested in the reclamation of such lands.

(3) To disseminate in available form the results of the investigations and to encourage land drainage by emphasizing the benefits to be derived from bringing such lands under cultivation.

This work, inaugurated by Arthur M. Shaw, Drainage Engineer, and the writer, has been continued since 1909 by Chas. W. Okey, Drainage Engineer, and much information of value has been collected and made available.

The area of the individual drainage districts varies from

[1] The Wet Lands of Southern Louisiana and Their Drainage, U. S. Dept. of Agr., Bulletin 71, by Charles W. Okey.

a few hundred acres in the smaller districts to several thousand acres in the larger ones. The pumping capacity in 24 hours was found to vary from less than 0.9 to 1.51 in. These figures represent average practice in Louisiana and are being used as a guide in deciding the capacity of drainage pumping plants for agricultural lands.

Mr. Okey sums up the records of a rainfall and run-off from four drainage districts of Louisiana, as follows:

In the year 1914 the results from the Poydras, Des Allemands, Jefferson, and Raceland plants may be said to be typical. In addition, the results from the last-named district for 1913 are also typical. An average of the records for 1914 for each of the districts and including the records for 1913 from the Raceland district, gives the following results:

Rainfall	50.85 in.
Run-off	22.59 in.
Days per year on which operation occurred	104
Number of times per year boilers were fired	97
Number of 24-hour days per year at full capacity	21.1
Average number of hours run at full capacity per fire-up	5.2

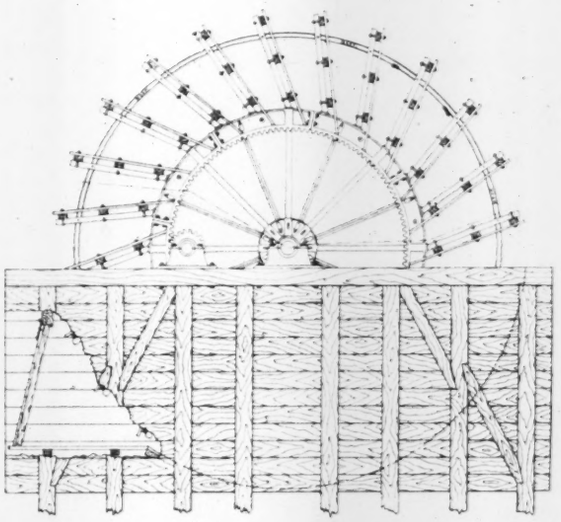

FIG. 3 DRAINAGE WHEEL, SOUTHSIDE PLANTING COMPANY

While the above rainfall is slightly below normal for this section of the State, it is believed that the percentage of rainfall appearing in run-off in the above average will not be far from normal. With the mean annual rainfall of 56 in. and the same percentage, the amount to be pumped would be 25 in. per year. Therefore a plant with a 24-hour capacity of 1.25 in. in depth of water over the area drained would have to operate an average of about 20 days of 24 hours each, per year. Where such factors as leaky levees enter in, the amount of pumping would of course be greatly increased. Where the capacity of the plant is much less than specified above, the amount pumped would be somewhat less, due to evaporation prior to pumping.

It must not be thought that the large rainfall and run-off impose too great a burden in the cost of pumping water from the reclaimed wet prairie lands. Information has been collected and compiled by C. W. Okey in regard to the cost of operating several drainage pumping plants for periods varying from two to eight years and for a variety of types in equipment. The tabulated costs include fuel, labor, repairs and incidentals. The figures indicate that the cost per acre per year will range from $0.50 to $1.25, depending on the sort of machinery used, the cost of fuel and the peculiarities of the season. For those using steam plants he finds the cost of fuel per acre foot, lifted one foot, less with Corliss engines than with slide valve engines. For average seasons, in each case, the depth of water to be removed from land in drainage is less than the depth of water pumped onto the land in rice irrigation and the average lift in drainage is much less than that in irrigation.

THE DRAINAGE WHEEL

The first pumps to be used in the Gulf Coast country for artificial drainage were undoubtedly of the "drainage wheel" or "scoop wheel" type. The latter term is misleading, for it would seem to imply that the paddles were made in the form of scoops, which is not the case. The paddles are usually straight boards, inclined back at the periphery of the wheel. Small drainage wheels have been operated by horse or mule power, and there are many of the steam-driven drainage wheels yet in use in Louisiana. Some are of venerable age, while others date from a comparatively recent period. Many of the old drainage wheels of the sugar plantations worked between brick piers that were substantially constructed. Some of the later installations used foundations of wood, resting on long piles. The cost of foundations and the difficulty of holding

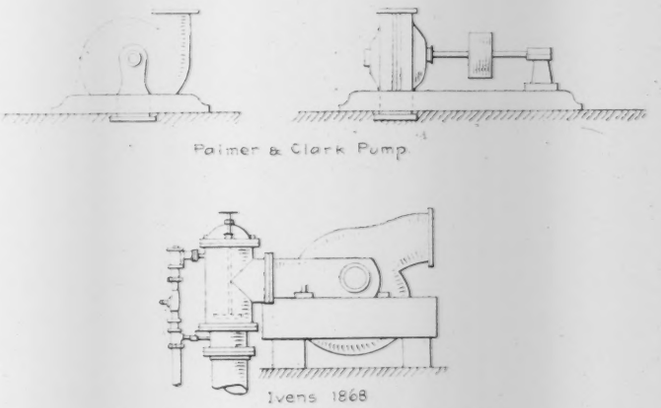

FIG. 4 TYPES OF CENTRIFUGAL PUMPS

them rigidly in most localities has increased the cost of the drainage wheels to such an extent that they have been practically eliminated from competition with other cheaper forms of pumping plant.

A point against the drainage wheel is the difficulty involved in adjusting its height. Once set, the depth to which the water may be lowered is definitely fixed. As a rule these wheels are expected to pump against a maximum head equal to one-fourth the diameter. The large steam-driven wheels usually range from 28 to 32 ft. in diameter with a width of from 4 to 7 ft. The humus of the reclaimed land in time disappears as the land is cultivated and the level of the land seems to fall. The amount of shrinkage varies with the conditions as the depth of humus is not uniform. As a result, after a few years it has been found desirable to pump to a lower level and with a drainage wheel it requires either a lengthening of paddles or the lowering of the foundations and power plant.

TESTS OF DRAINAGE WHEELS

The writer made a test of a drainage wheel in 1905 used to drain the sugar plantation of the South Side Planting Co., on the right bank of the Mississippi River, opposite New Orleans. The plantation contained 1700 acres, 1600 of which were then under cultivation. Fig. 2 shows this wheel.

Open ditches were used exclusively. The smaller ones were brought together successively and terminated in a large canal leading to the drainage wheel. The water drained away from the river. The flow was obtained by deepening the ditches as

they approached the pumping plant, as well as from the natural slope of the land. Here the water was elevated and then flowed back into the swamps. The plantation was protected from backwater by means of a levee.

The general design of the wheel and method of bracing are clearly shown in Fig. 3. It is a type of its class, but has some distinct features in the double gearing and in the number of paddles. Care was exercised so to design the wheel that the water would not be lifted unnecessarily. The backward flow through the pump wheels when at rest was prevented by the swinging door shown in Fig. 3.

The diameter of the wheel is 28 ft., and the width 6 ft. It is driven by a simple non-condensing engine of the slide valve type, having a cylinder 16 in. in diameter and a stroke of 24 in. The steam pressure was 40 lb. or less and wood was ordinarily used as fuel.

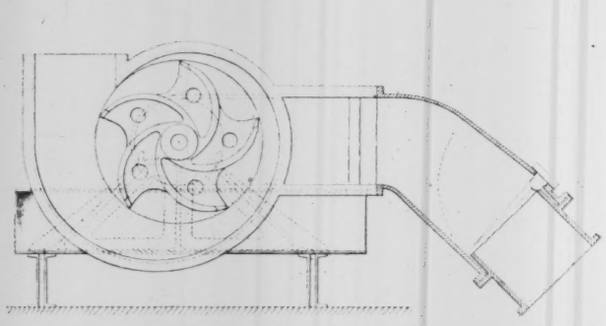

FIG. 5 IVENS CENTRIFUGAL PUMP, HORIZONTAL SHAFT

The test was made while pumping out the canal system and was necessarily short, lasting only about an hour. The method of testing consisted in traversing the discharge flume with a current meter and taking indicator cards and other observations as quickly as possible after traverse was finished. By this means the indicated horsepower was a little less than the mean corresponding to the water measurement, but as the latter required only about ten minutes, the error was not great. This method was rendered necessary by lack of observers.

The results given below are very satisfactory, as they show an efficiency of engine, transmission gears, and pump in every case exceeding 38 per cent, and in two cases considerably above that figure, while the actual lift of the pump varied from 2.4 ft. to 2.86 ft. During the last observation the paddles dipped into the water to a depth of approximately 1 ft., and the slip or backward flow was quite large. The clearance on the sides of paddles was about $\frac{3}{4}$ in.

LOCATION, SOUTHSIDE PLANTING CO.

Steam pressure, average, lb	38.2
Speed of engines, average, r. p. m.	66.1
Indicated horsepower, average	9.68
Speed of wheel, average, r. p. m.	2.22
Head, average, ft.	2.69
Discharge, average, cu. ft. per sec.	14.34
Useful water horsepower, average	4.27
Efficiency, average, per cent	43.4

These results are confirmed by a test made by W. M. White, Mem.Am.Soc.M.E., of a similar drainage wheel in New Orleans in August, 1900. The wheel tested was used at that time in one of the city drainage stations at London Avenue. Since the inauguration of the new drainage system it has been taken down and removed.

The log of the test shows that between 50 and 60 cu. ft. of water per sec. were pumped through a height varying from 4 to 5 ft. The efficiency of engine, gearing and pump ranged from 45 to 50 per cent. The duty per 100 lb. of coal was approximately 13,000,000 ft-lb.; the water rate of the engine 50.5 lb. per i.h.p-hr. The engine was of the type used in Mississippi River steamboats; diameter of cylinder 18 in., length of stroke 54 in. During the test the engine made about 35 r.p.m.

The drainage wheel was used extensively in this city previous to 1900. The combined capacity of the drainage wheels in the drainage equipment of New Orleans previous to the inauguration of the present system was 1170 cu. ft. per sec. with a lift of 5 ft. The one centrifugal pump then in use brought the total amount up to 1214 cu. ft. per sec. However, the accuracy of the capacity rating of these wheels is in doubt. While a capacity of 300 cu. ft. per sec. with a lift of 5 ft. was claimed for the two London Avenue machines or 150 cu. ft. per sec. for each, the test made by W. M. White in 1900 gave between 50 and 60 cu. ft. per sec. with a lift of approximately 5 ft. However, it is possible that the machinery might have been speeded up and the capacity considerably increased.

THE CENTRIFUGAL PUMP

So far as the writer has been able to learn, the first centrifugal pump manufactured in the State of Louisiana was

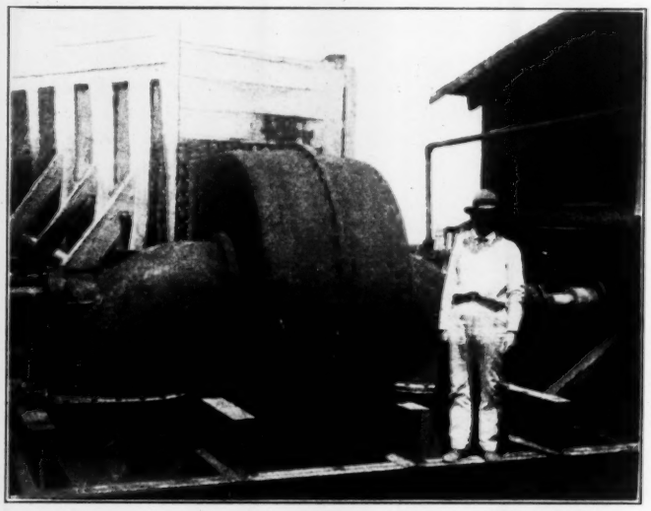

FIG. 6 IVENS PUMP AT ACADIA CANAL RELIFT

made by John Clark, a prominent foundryman, in the early fifties. It was similar in design and construction to the Palmer pump which had been used with varying success about that time in drainage work. The origin of the Palmer pump is uncertain.

Both pumps were decidedly crude as there was very little machine work done on them and all joints were made with red lead, excepting that between the shells, which was composed of sal ammoniac and cast iron borings. The vertical suction extended through the bed plate and great difficulty was experienced in making a satisfactory joint with the suction pipe.

The centrifugal pump in some of its various forms has proved to be a favorite for the work of irrigation and drainage where large volumes of water must be elevated through only a few feet lift. In Fig. 4 are diagrams of two of the early types of centrifugal pumps.

There are many reasons for the popularity of the centrifugal pump among which may be mentioned low first cost, reliability of operation and simplicity of construction. If properly designed for the conditions under which it is to

operate, it is efficient. Twenty-five years ago efficiencies of 50 to 60 per cent were considered good practice where the lift was moderate. Today many different centrifugal pumps may be found in irrigation work that have shown efficiencies of more than 80 per cent under carefully conducted tests. Drainage pumps of the centrifugal or screw type or a combination of both have developed efficiencies on lifts less than 10 ft. that were thought impossible a few years ago.

It has also been realized that the design of the pipes to conduct the water from the suction basin to the pumps and from the pumps to the discharge basin or flume is well worthy of careful consideration. A few years ago it was a common practice to use straight suction and discharge pipes having the same diameter throughout. In recent years examples of this kind of ignorance of the fundamental laws of hydraulics have been uncommon in the Gulf Coast country, although they are found in parts of the Mississippi valley and occasionally descriptions of such plants find their way into the technical press.

In drainage installations where the lift is usually between 4 ft. and 10 ft., the losses at the entrance of suction pipes

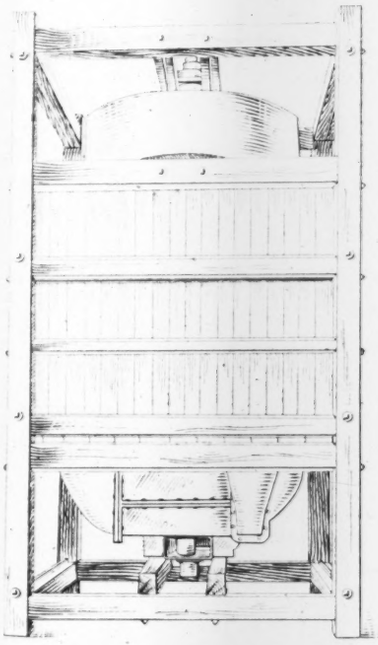

FIG. 7 IVENS QUADRUPLE DISCHARGE PUMP, BOX TYPE

and the kinetic energy that may be thrown away at the end of the discharge pipe, together make up a large percentage of the energy required. The entrance loss in feet of water is usually estimated at 0.93 of the velocity head at the entrance. The discharge loss is equal to the velocity head at the end of the discharge pipe. If the pipes are round and the diameter is doubled at suction and discharge end, the area is multiplied by four and if pumping a constant quantity of water there will be entrance and discharge velocities one-fourth as great as with straight pipes. Losses vary as the square of the velocity so they will be reduced to one-sixteenth of the loss of a straight pipe, if the diameter of the ends of suction and discharge pipe are gradually enlarged to twice the diameter of the straight pipes, or if not round in cross section, the area is increased to four times that of the original pipe.

In the late sixties the Ivens pump was invented by Edmund M. Ivens of New Orleans, grandfather of E. M. Ivens, Junior Member of the Society. It was mounted on a heavy wooden frame, and was readily installed over the intake or suction water and discharged through a flume bolted to the discharge.

The pump was fitted with a surface valve to which was connected a steam jet. The jet discharged through a check valve, thus priming the pump. During the process of priming, the connecting valve on the lower side of jet was opened slightly and vacuum established between valve and suction water. When in operation the valve rode the suction column, thus permitting the full area of suction opening. The pump was

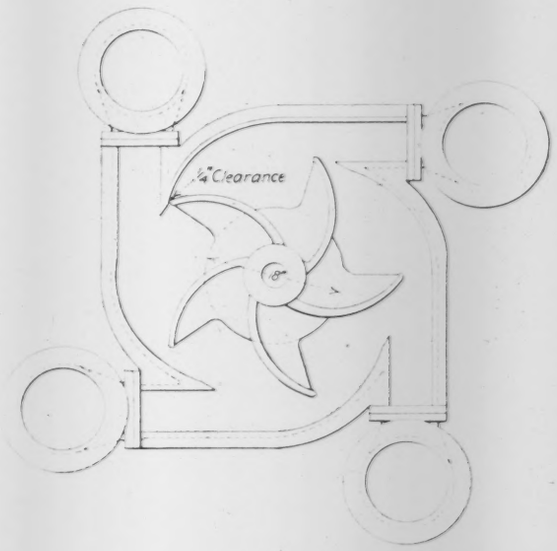

FIG. 8 DIAGRAM OF CASING AND IMPELLER, IVENS QUADRUPLE PUMP

properly finished and on account of the results obtained is prominently identified with the drainage work of that period, in this section. Later on it was used in rice irrigation.

The Ivens pump was made in a variety of forms and sizes. Vertical shaft iron pumps had double suction openings. The smaller sizes had a single suction pipe but cored passages around the outside of the volute of the pump so that water entered the impeller from both sides. In the largest size independent suction pipes were used. The writer tested several Ivens pumps during the irrigating season of 1905 and the results from two different plants here follow.

TESTS OF IVENS CENTRIFUGAL PUMPS

A test was made by the writer on July 31, 1905, of the pumping plant forming the first relift of the Abbott-Duson canal system. The plant is located at Egan, La., about 2½ miles east of the main pumping plant. There are two Ivens pumps rated as 36 in., but the lift is so small that the pumps each discharge through a rectangular opening into a separate flume, having gradually expanding cross sections. The two flumes are brought together at a distance of about 50 ft. from the pumps into a larger flume, which discharges into the canal beyond the plant.

The boiler equipment consists of three horizontal return tubular boilers, 72 in. in diameter by 18 ft. long, each containing seventy-two 4-in. tubes. Crude petroleum is used as fuel. The two pumps are driven through the medium of a rope driven by a simple condensing Corliss engine, 24 in. diameter of cylinder and 48-in. stroke. The flywheel is 16 ft. in diameter and has 18 rope grooves. There are 1850 ft. of 1¼-in. rope required for the drive.

Under ordinary conditions an open heater is used. A direct-acting steam pump furnishes water to the heater, and a similar pump takes the water from the heater and delivers it to the boilers. The heater receives the exhaust from these two pumps and also from the condenser pump. During the test the heater was not used, as the water had to be measured. The piping was changed so that one of the pumps furnished water to fill two calibrated barrels, so placed that they could be emptied through a 2-in. valve into a lower barrel. The suction of the second pump was attached directly to the lower barrel, and this pump was used to feed the boilers.

The measurements of the water discharged by the pumps were made by the pitot tube. The discharge flume in which the measurements were made was 18.75 ft. wide. The depth of water varied from about 1.5 ft. to a little over 1.6 ft. The

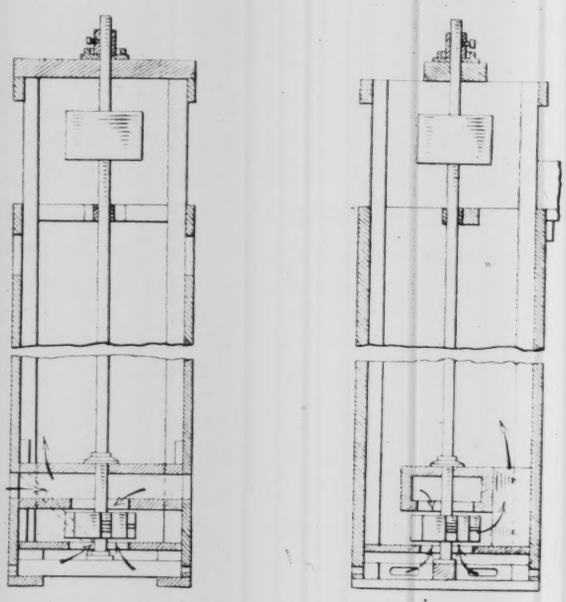

FIG. 9 MÉNGE PUMP

cross section was divided into 20 rectangles of equal size and the mean velocity obtained at the center of each rectangle, or, in other words, the velocity was observed at ten different stations across the flume and at two different depths at each station.

The crude petroleum used for fuel during the test was measured in a calibrated barrel, the amount per hour being 712 lb. The following day fuel oil was measured for 1 hr., and 57 min., the feed-water heater being in use. It was found that the consumption of oil per hour was 603 lb. The temperature of water entering boiler was 200 deg. fahr. instead of 92 deg. fahr., as found when heater was not used. The theoretical gain by using the feed water is about 11 per cent, while the actual difference in fuel used amounted to nearly 20 per cent. The discrepancy is accounted for by the difference in the amount of water present in the fuel oil. For example, during the test on July 31 the amount of water in the fuel oil was sufficient to put out the fires momentarily on two occasions, and to require careful oversight of the oil burners to prevent irregularities in the amount of combustion and, consequently, in steam pressure. On the second day the oil in the supply tank had become quite thoroughly separated from the water, the latter having settled to the bottom, and the result was that there was no trouble with the burners.

During the test, indicator cards were taken at 15-min. intervals, and observations were made of steam pressure, vacuum gage, revolutions of engine and pump, and of head pumped against. At intervals of a half hour water measurements were taken in the flume, and the temperature of water, oil and air was noted. The amount of water and fuel oil used was also carefully noted.

The efficiency of engine, transmission and pump is excellent—in fact, the best of any of the plants tested in 1905 in which centrifugal pumps are used. This efficiency had an average value of 64.2 per cent. If the efficiency of the rope drive is assumed to be 95 per cent and the mechanical efficiency of the engine as 90 per cent, the efficiency of the pump is found to be about 75 per cent. The results of the tests are as follows:

LOCATION, FIRST RELIFT, ABBOTT-DUSON CANAL.

Duration of test, 4 hr.
Total fuel oil, 2886 lb.
Average steam pressure by gage, 65.6 lb. per sq. in.
Average temperature of feed water, 92 deg. fahr.
Factor of evaporation, 1.157.
Total weight of water fed to boiler, 28,629 lb.
Equivalent water evaporated from and at 212 deg. fahr., 33,112 lb.
Boiler horse-power, 240.
Average temperature of fuel oil, 171 deg. fahr.
Average air temperature, 92 deg. fahr.
Water apparently evaporated per pound of oil, 9.92 lb.
Equivalent evaporation from and at 212 deg. fahr. (not corrected for quality of steam), 11.47 lb.
Total feed water (including steam used by auxiliaries) per indicated horse-power hour, 31.2 lb.

Average speed of engine, r.p.m.	66.8
Average indicated horse-power	229.8
Average speed of pump, r.p.m.	118.5
Average head, ft.	11.24
Average discharge, cu. ft. per sec.	115.4
Average useful water horse-power	147.1
Average efficiency, per cent.	64.2

The Acadia relift, which was tested by the writer in August, 1905, is located on the main Acadia Canal, about a mile north of Iota, La. The pump is nominally an Ivens 36-in. pump, similar to those at the Abbott-Duson first relift, and having two suction pipes 24 in. in diameter (see Fig. 6).

The equipment of this plant includes two horizontal return-tubular boilers 72 in. in diameter by 18 ft. in length, each containing seventy-two 4-in. tubes. Fuel oil is used. The boilers are fed by means of two direct-acting steam pumps. One pump takes water from the canal and furnishes it to the open heater. Another pump takes the water from the heater and pumps it into the boiler. Both pumps and the engine exhaust into the heater.

The engine is a simple, non-condensing Corliss, cylinder diameter 22 in., stroke 42 in. The pump is driven by rope drive. There are 10 grooves in the engine flywheel and 958 ft. of $1\frac{1}{2}$-in. rope are used.

The discharge from the pump was measured in the flume about 50 ft. from the pump. At this place the flume had a uniform cross section 9.27 ft. wide and about 1.8 feet deep. A current meter was used and the cross section slowly traversed at three different depths to obtain the mean velocity in all but two observations, when the pitot tube was used. With the latter instrument the velocity was observed at ten different stations across the flume and at three different depths in the first observation and at two different depths in the second.

The arrangement of the plant is similar to that of the Abbott Duson first relift, except that there is only one engine and one pump, instead of one engine and two pumps. Both the engine and the rope drive were larger in the case where two pumps were used, but the loss due to friction in the two cases probably was not very different. The height through which the water was lifted was a little greater with the two

pumps than with the single pump of the Acadia relift, and this probably had some effect on efficiency.

It was practically impossible to make a complete boiler test because the necessary changes in the piping could not be made for measuring the feed water. Fuel oil, however, was measured by means of a calibrated barrel, and a partial boiler test of 4.45 hours duration was run, during which time the average steam pressure by gage was 79.4 lb. per sq. in. and 1567 of fuel oil were consumed. The data of the engine and pump test are given below:

LOCATION, ACADIA RELIFT.

Duration of test, 4 hr.	
Steam pressure, average, lb.	79.4
Speed of engine, average, r. p. m.	68.8
Indicated horse-power, average	137.7
Speed of pump, average, r. p. m.	117.2
Head, average, ft.	9.49
Discharge, average, cu. ft. per sec.	71.4
Useful horse-power, average	76.5
Efficiency, average, per cent.	55.6

The Ivens pump was made in a special form for low lifts. A wooden box was used for the body of the pump. Into the box the impeller discharged its water through two or four expanding nozzles. The impeller, the vertical shaft and the parts surrounding the impeller including the cast iron nozzles, were made of metal while the remainder was constructed of wood. Figs. 7 and 8 show some of the details of this pump which was especially adapted to drainage where low lifts prevail.

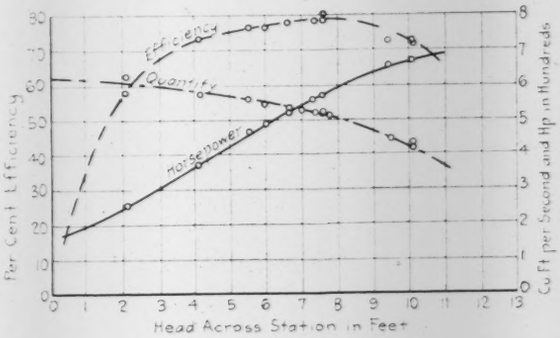

FIG. 11 TESTS OF 12-FT. SCREW PUMP

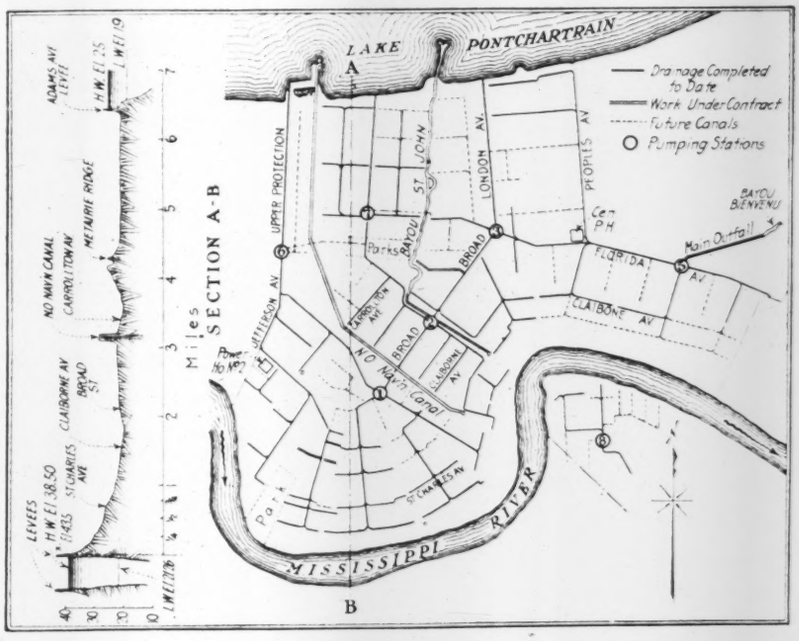

FIG. 10 MAP OF NEW ORLEANS SHOWING COMPLETED AND PROPOSED DRAINAGE CONSTRUCTION

THE MENGE PUMP

The Menge centrifugal pump was brought out by the late Joseph Menge, to whom patents were issued in 1888 and 1891. S. L. Menge, son of Joseph Menge, patented in 1910 an improvement in the number and area of passages by which the water enters the pump.

As ordinarily constructed, the body of the pump is of wood, although concrete has occasionally been used. The shaft is vertical and the impeller is submerged in the water to be pumped. The openings in the bottom of the pump box were arranged to admit water both above and below the impeller. A ball bearing at the top of the shaft takes the weight of the moving parts. Aside from the shaft, impeller and bearings the pump is entirely of wood and can be easily and cheaply erected. As the water pours over the top, the quantity of water pumped is impressive.

The pump is made with impellers varying in size from 8 in. diameter by 4 in. high to 60 in. diameter by 20 in. high, and in rated capacities from 833 gal. per min. to 60,000 gal. per min. Either a belt or rope driver is used to connect the pump with the source of power. Sectional views of the Menge pump are shown in Fig. 9.

A single impeller is used for low lifts, while for higher lifts two or three impellers are arranged at intervals on the same shaft. The pump was justly popular from the time of its inception because of its cheapness and its ability to handle large quantities of water at good efficiencies, especially at low lifts. In the drainage of sugar plantations this pump found a particularly favorable field and it has been used quite exclusively in rice irrigation.

The Menge pump is still extensively used in this territory and several thousand are in operation in various parts of the United States and in foreign countries. The writer has made several efficiency tests of Menge pump installations, both for drainage and irrigation. Where the pumps were favorably located and the plants in good condition, the efficiencies were excellent. In a few cases where the pumps were set to lift the water higher than was necessary, or the wooden box was allowed to get out of repair, the results were not so good.

The results obtained from a test of a drainage plant made at Paradis, Louisiana, Sept. 16, 1909, are of interest: With an engine speed ranging from 81 to 116 r.p.m., and the pump operating against a difference in head of from 3.42 to 5.30 ft., the combined efficiency of engine and pump varied from 36.2 to 47.1 per cent. The indicated horsepower of the engine ranged from 22 to 76.5 h.p. and the water horsepower from 6.4 to 33.7. If the mechanical efficiency of the engine be asumed as 90 per cent and the efficiency of transmission 95 per cent, the efficiency of the pump will be approximately 55 per cent with a 5-ft. lift.

The plant consists of a 48-in. by 18-in. Menge pump run by means of a rope drive from an Atlas steam engine, diameter of cylinder 14 in., stroke 20 in. Various speeds of rotation were employed for the purpose of finding the best efficiency.

The results were excellent and have been confirmed by tests of other plants.

THE STREAM PUMP

The E. L. Stream centrifugal pump was manufactured in 1891 by H. Dudley Coleman & Brother of New Orleans. It was a side inlet pump, the main feature of which was the method of attaching the suction elbow by a threaded nipple with a jamb ring. By this means the suction could be pointed at any desired angle to meet the condition of a falling river, as the angle of the suction could be changed to conform to the surface line of the batture, without dismantling the pump.

RICE CULTIVATION

Louisiana has cultivated rice for many years. Directly after the Civil War the abandoned sugar plantations were planted

FIG. 12 12-FT. SCREW PUMPS, DRAINAGE STATION NO. 1

to rice and this grain became one of the staple crops of the state. For several years planters were allowed to place flumes in the levees for the purpose of irrigating their rice fields. The flumes became a menace during high water and several crevasses were directly due to leaks around flumes in high water. This led to the passage of the law prohibiting their use. Since that time siphons have been used over the levees. In years of extreme low water, it is necessary to pump the water from the river to shallow pools that supply the siphons. The pumping plants are usually very crude.

By far the greater part of the rice crop is now raised on the upland prairies. The increase in the amount of rice produced in the Gulf States has been due chiefly to the utilization of these lands. The water for irrigation must be pumped, the lift varying from a few feet to 55 ft. or more.

IRRIGATION PUMPS FOR RICE

The rapid increase in the rice industry, beginning in the early nineties, created a demand for pumping machinery in the prairie country of Southwest Louisiana and many different types were installed. Among the first of the larger pumping plants, erected near Crowley, La., was one which consisted of two cast iron vessels, into which steam at a moderate pressure was introduced alternately. On condensing the steam by means of a spray of water, a vacuum was formed and water entered through suction pipes, partially filling the vacuum. The vessels were placed sufficiently high to allow the water to flow from them to the land to be irrigated. Valves were opened automatically to accomplish the various steps referred to above.

The process of pumping was slow and the capacity small when compared to plants of similar size but operating on more modern systems. Worse than this, the pumps failed to act at a time when water was most needed, because the water used for condensing had become too warm, and consequently the vacuum formed was not sufficient to raise the water to the height of the vessels. Mechanical engineers will recognize this pump as very similar to the one used by the Marquis of Worcester and described by him in 1663.

Among the other freak designs for pumps in the early days of rice irrigation by pumping, there was a pump that scooped up water at the periphery of a large wheel and discharged it near the axis. The water passages were spirals. The wheel was about 25 ft. in diameter with a width of about 6 ft. It was driven by gearing in a manner similar to the drainage wheels. This type might, with propriety, be called a "scoop" wheel. At least one of these wheels was built for irrigation and another for drainage. The type has now disappeared.

The Hollingsworth Water Elevator was another curiosity. It was built with a shallow inclined flume up which water was carried by slats attached near their ends to sprocket

FIG. 13 DISCHARGE FROM ONE SCREW PUMP AT STATION NO. 1

chains. The head and tail shafts were fitted with sprocket wheels, over which the chains traveled. The outfit was carried by a wooden frame and means were provided to raise or lower the upper end. The tail end was submerged several feet in suction water and by the rapid motion of the slats, the water was elevated and discharged over the upper end. The head under which the pump worked was from 1 ft. to 10 or 12 ft.

CAPACITY OF PUMPING PLANTS FOR RICE IRRIGATION

It was about 22 years ago that the first large irrigation pump was installed to irrigate rice on the prairie lands of Southwest Louisiana. At that time there was little definite knowledge regarding the capacity for a given acreage. The rainfall was fairly abundant and usually well distributed so much so that "Providence" rice had often been successfully raised. However, the uncertainty of rain at the most critical period of the growth of the crop and the small amount of land favorably situated to receive the run-off of higher lands,

soon led to the installation of pumping plants. The judgment shown in the selection of the capacity was, of course, widely variable.

Profiting by early mistakes and guided by the results of measurements made on canal systems and rice fields by the U. S. Dept. of Agriculture, the capacity became standardized. On the prairie lands where the soil and subsoil contains a large amount of clay so that the seepage is practically nil, the amount should be from 7½ to 8 gal. per min. for each acre irrigated, depending somewhat on the character of the soil and the distance from pumping plant to the field where the water is to be used. In some localities where the nature of the soil is such that it will allow more seepage, as much as 10 gal. per min. should be provided for each acre irrigated and in land having a loose subsoil where the seepage is large, the capacity needed may be as much as 30 to 40 gal. Only in isolated cases covering small areas are these large capacities required.

The total quantity of water to be pumped in a season into the large canals varies from less than 2-acre feet to 3-acre feet per acre of rice irrigated, with the average approximately 2½ acre-feet per acre. The actual plants with their canal systems vary in size from that of the Neches Canal Co., near Beaumont, Texas, which irrigated 26,853 acres in 1914, down to the individual well plant that irrigates only from one hundred to two hundred acres. About 1900 small well pumping plants have been installed in the rice country. In Louisiana the favorite source of power is the steam engine. In Texas, while steam is used to some extent, gasoline engines are largely employed. In Arkansas both the gasoline and steam engine are used.

The earlier well pumps were usually vertical shaft centrifugal type, 4 in. to 8 in. in diameter and placed in pits about 6 ft. square, dug by hand to a depth of from 30 to 50 ft. Trouble was experienced in keeping the shaft in line and this was overcome in a measure by means of the "Munger Attachment," an arrangement for rigidly fastening the bearings to the discharge pipe.

Another design of a well pump for an open pit by Stamm, Scheele & Co., of Rayne, La., had two discharge pipes on opposite sides and the bearings for the shaft were rigidly supported between the two pipes. The wood-lined pits gave considerable trouble and in the early nineties the steel pit centrifugal pump appeared. This is the only type installed for wells at present.

The Census of 1910 showed a total acreage of rice harvested in the United States of 610,175. The acreage in the Gulf Coast States was as follows:

	Acres.	Per Cent of Total in U. S.
Arkansas	27,419	4.5
Louisiana	317,518	52.0
Texas	237,586	38.9
	582,523	95.4

Since the census was taken, rice has been successfully raised in California, where it is a rapidly growing industry. There has also been an increase in the acreage in Arkansas, but Louisiana and Texas together continue to produce over 80 per cent of the rice grown in this country.

The relative importance of pumping plants in the rice territory of the Gulf States is well known by the irrigation census of 1910, which showed that the water used on 88.7 per cent of the acreage in Louisiana was pumped, in Texas, 98.8 per cent and in Arkansas, 90.8 per cent. The water that was not pumped was carried to the fields by gravity from flowing wells, from lakes and streams and through siphons along the lower Mississippi River, where the water during the irrigation season is higher than the land behind the levees.

TABLE 1 DATA ON DRAINAGE PUMPS

Sewerage and Water Board, New Orleans

Pumping Station Number	Number of Units Installed	Capacity of Unit Cu. Ft. per Sec.	Nominal Head in Feet Pumped Against	Revolutions per Min.	Guaranteed Efficiency of Pumps, per Cent	Ave. Efficiency of Pumps During Acceptance Test at Head for which Designed	Diameter of Suction Pipe, In.	Diameter of Discharge Pipe, In.	Combined Length of Suction and Discharge Pipes in Ft.	Type of Pump	Shaft	Type of Impeller	Diameter of Impeller, In.	Horsepower of Motor Driving Pump	Remarks
1	3	250	5	88	60	54	96	96	55	screw	vertical	.....	108	266	Driven by three-phase synchronous motor
2	2	250	5	88	60	56.5	96	96	60	screw	vertical	.....	108	266	Driven by three-phase synchronous motor
3	2	250	8	82	60	63	84	84	70	centrif.	horiz.	enclosed	84	400	Diam. bell suction pipe 108 in. Diam. suction inlet to pump 69 in. Diam. suction pipe 84 in. Diam. bell discharge pipe 120 in.
5															
6	4	250	10	62.5	65	66.6	96	96	60	centrif.	vertical	enclosed	114	466	Driven by three-phase synchronous motor
7	3	250	10	62.5	65	no test	96	96	60	centrif.	vertical	enclosed	114	466	Driven by three-phase synchronous motor
1	1	40	10	167	60	58	42	42	55	centrif.	vertical	enclosed	49.5	149	Driven by three-phase synchronous motor
2	1	40	10	167	60	60	42	42	60	centrif.	vertical	enclosed	49.5	149	Driven by three-phase synchronous motor
3	1	50	12	100	60	58.3	36	36	70	centrif.	horiz.	enclosed	81	120	Diameter bell suction pipe 54 in. Diam. bell discharge pipe 60 in.
5	1	150	8	125	65	no test	36	52	71	centrif.	horiz.	open	72	400	Driven by triple expansion engine
5	1	150	8	125	65	no test	36	52	71	centrif.	horiz.	open	72	333	Driven by three-phase synchronous motor
8	1	150	8	125	65	no test	36	52	71	centrif.	horiz.	open	72	400	Driven by triple expansion engine
6	1	30	13.5	260	60	65.9	30	30	60	centrif.	vertical	enclosed	37	100	Driven by induction motor
7	1	30	13.5	260	60	65.9	30	30	60	centrif.	vertical	enclosed	37	100	Driven by induction motor

NEW ORLEANS MODERN DRAINAGE SYSTEM

The drainage of New Orleans and the sanitary sewers belong to separate systems. Work was begun on the modern drainage system in 1896 and it went into operation in 1900. The reports of the Drainage Board and later of the Sewerage and Water Board give the details of the various installations. Table 1 is from the Twenty-fourth Semi-Annual Report of the Sewerage and Water Board, December, 31, 1911. A map is also reproduced in Fig. 10 from the Semi-Annual Report, December 31, 1914, showing the completed and proposed drainage construction.

According to a recent report by Geo. G. Earl, general superintendent of the Sewerage and Water Board, the capacity of pumping plants for drainage will eventually be equal to 7.33 in. of run-off removed in 24 hours. The present capacity is about 3.5 in. The area drained amounts to 25,000 acres, or a little more than 39 square miles. It is believed that no other city in the world has such enormous volumes of drainage water to dispose of.

The pumping capacity for the drainage of the city is being increased by the installation of eleven 12-ft. screw pumps to be used in Drainage Pumping Plants Nos. 1, 2, 3, 5, 6 and 7. The test of one of these pumps reported in Engineering Record, Jan. 8, 1916, by Geo. G. Earl and in Engineering News of Jan. 13, 1916, by Prof. W. H. P. Creighton, shows efficiencies above 70 per cent for lifts between 3.5 and 10.5 feet. The efficiency curve rose to nearly 80 per cent at approximately 7.5 ft. lift (Fig. 11). The quantity of water pumped varied from 600 cu. ft. per sec. at a 3-ft. lift to 400 cu. ft. at a lift of 10.5 ft.

These pumps were built by the Nordberg Manufacturing Co., of Milwaukee, from designs by A. B. Woods, Mechanical and Electrical Engineer of the Sewerage and Water Board. In Fig. 12 is a view of the large pumps in drainage station No. 1 of the New Orleans system and in Fig. 13 a view showing the discharge from one of these pumps.

CHAMBER WHEEL PUMPS

Chamber wheel pumps made by the Connersville Blower Company, or the P. H. & F. M. Roots Co., of Connersville, Indiana, have been used in irrigation and drainage work in this section.

The largest rice irrigation enterprise in all the Gulf Coast country, that of the Neches Canal near Beaumont, Texas, uses Connersville pumps at the first lift to elevate water from 30 to 35 ft. There are six units, having a total capacity of approximately 200,000 gal. per min.

The water is carried for about two miles through a canal, having levees 150 ft. between crowns, where it is again elevated about 7.5 ft. by two Connersville units and one centrifugal pump built by Morris Machine Works, Baldwinsville, New York.

A test of the main pumping plant of the Neches Canal was made in 1906 and reported in Vol. 28, Transactions of this Society under the title, "Tests of a Rotary Pump." The test made showed a remarkable efficiency for the pumps and the results were confirmed by a test at the same plant made in August, 1915, when almost identical results were obtained. No adjustments of the pumps in the two units tested have been necessary during the twelve years they have been used.

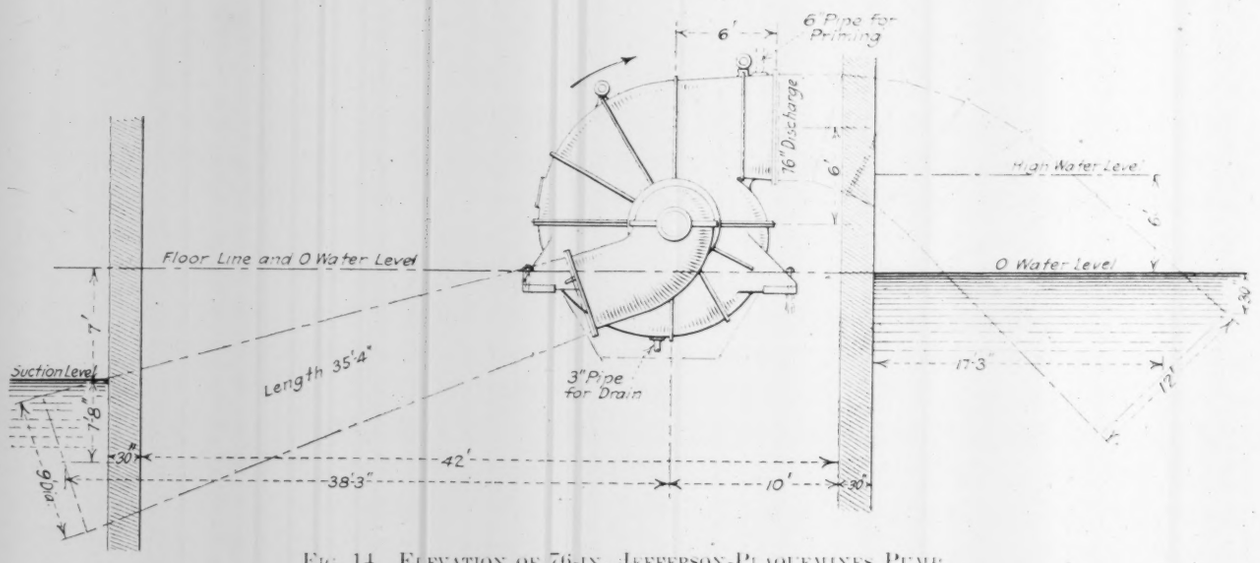

FIG. 14 ELEVATION OF 76-IN. JEFFERSON-PLAQUEMINES PUMP

The installations of rotary, chamber wheel pumps for rice irrigation have not been an unqualified success; there have been many troubles with some of the plants, partly because of the lack of proper talent in their operation. However, the writer has for years visited pumping plants of this type in which trouble was conspicuous by its absence, largely because of the high-grade men in charge.

As a drainage pump, where built in large units, such as are required ordinarily in drainage work, the pumps lift the water higher than is necessary and while they are efficient if credited with the higher lift, they lose their efficiency on low lifts, when actual difference of levels is considered.

This point is well illustrated by the drainage pumping plant of Willswood Plantation. This is an old river-front plantation of 2400 acres, on the Southern Pacific Railway, ten miles above New Orleans. About one-third of this tract is sloping and has good natural drainage, though practically all of the water drains into the main canal system and is handled by the pumps. An intermediate area, containing approximately one-third of the whole, has been in cultivation for a number of years, drainage originally being secured by means of a large wheel pump. About 19 years ago, several hundred acres were added to the plantation by the construction of a new levee farther back on the prairie. New canals were dug, a new pumping plant installed and the old wheel pump abandoned.

There are three pumping units on this plantation, steam being furnished by two water tube boilers and one horizontal, return tubular boiler. The fuel used is crude oil and a feed water heater is used. Following is a description of the three units:

1 A 16-in. by 24-in. automatic, non-condensing engine, connected by rope drive to a rotary, chamber wheel pump. Maximum capacity of 40,000 gal. per min.

2 A similar engine, connected by rope drive and bevel gear to a Menge pump. Size of impeller 42 in. by 16 in.

3 A double vertical engine, direct-connected to a centrifugal pump. Diameter of discharge pipe, 36 in.

Pumps 1 and 2 discharge into open flumes at an average head on pump of about ten feet, which is about five feet greater than is necessary. The bottom of the discharge flume was placed at the elevation of the top of the back levee which normally was about 4 ft. higher than the water of the swamp behind the levee.

When the pump was credited with the head through which the water was elevated at the pump, the average efficiency of engine transmission and pump was found to be 60 per cent. Assuming the mechanical efficiency of the engine as 90 per cent and the efficiency of transmission as 95 per cent, the pump efficiency is a little more than 70 per cent.

FUELS

Irrigation and drainage plants used wood or coal for fuel previous to the opening years of this century.

The Lucas oil well was brought in, Jan. 10, 1901, at Spindle-

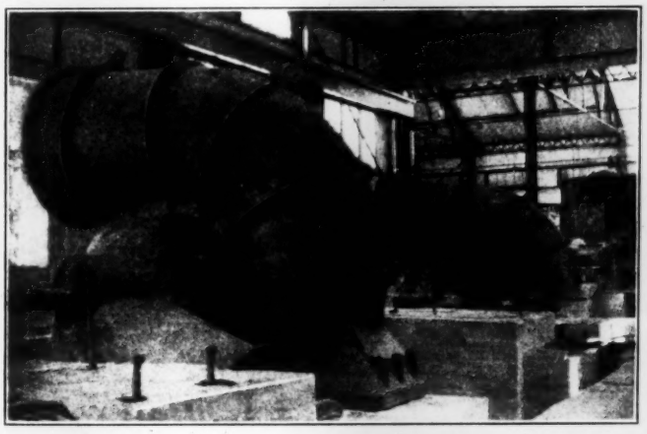

FIG. 15 76-IN. JEFFERSON-PLAQUEMINES PUMPS

top, near Beaumont, Texas. Soon after, oil was discovered at other fields, many of which were in or near the rice irrigation country, notably Jennings, Welsh, Vinton and Sulphur in Louisiana and Dayton, Sour Lake, Saratoga, Batson and Humble in Texas.

At first the production of crude oil was far in excess of the demand of the refineries and crude oil sold for as low as ten cents a barrel of 42 gal. at the fields. Later, as refineries were erected and means worked out to handle the output, the price of crude oil steadily advanced to from 75 cents to $1.50 per barrel and even more in some instances. The cost at any particular plant in the Gulf Coast country depends upon the transportation costs of delivery and the time of purchasing. Many of the nearby pumping plants were supplied by pipe lines from the oil fields. The problem of pumping both for irrigation and for drainage plants has been greatly simplified by crude oil as a fuel.

During the year 1915 the petroleum production of the United States as estimated by the U. S. Geological Survey was 267,400,000 barrels. Of this amount Texas produced 26,000,000 barrels or 9.72 per cent and Louisiana 18,500,000 barrels or 6.92 per cent.

TABLE 2 DATA UPON JEFFERSON-PLAQUEMINES PUMPS

Difference of Levels	Gallons per Minute	Duty in Millions of Foot-pounds per 1000 Lb. Dry Steam
76-in. Pump		
1	168,000	35
3	156,000	78
5	135,000	90
7	130,000	90
10	11,000	
13	9,000	
48-in. Pump		
3	47,500	60
5	45,000	80
7	42,000	75
8	40,000	70

FIG. 16 76-IN. PUMP DISCHARGE, JEFFERSON-PLAQUEMINES STATION

STRIKING EXAMPLE OF A MODERN DRAINAGE PLANT

The Jefferson-Plaquemines Drainage District, located on the right bank of the Mississippi, and extending in a southeasterly direction from a point nearly opposite the center of the city, comprises about 38,000 acres of land. The land along the river has been in cultivation for many years, but a large part forming the interior of the district was wet prairie. It is the largest drainage district in the State where water is pumped.

A large pumping plant is under construction and when completed the drainage coefficient will be $^{4}/_{10}$ in. removed in 24 hours. At present the equipment consists of two 76-in. pumps, each driven by a cross-compound engine, 16½ and 35 by 36 in., and one 48-in. pump driven by a cross-compound engine, 9 and 18 by 36 in. All the pumps are of the horizontal-shaft centrifugal type, designed to operate against differences of level varying from 1 to 13 ft. The engines are operated con-

densing, using surface condensers guaranteed for a vacuum, with water at 85 deg. fahr., of 26 in. of mercury. Three Heine boilers are used, one with 1380 sq. ft. and two with 2220 sq. ft. of heating surface, each. The steam piping is extra heavy and the whole plant gives the impression of excellent design, good materials and workmanship. The engines were built by the Nordberg Manufacturing Company, Milwaukee, and the pumps by the Southwark Foundry and Machine Company, Philadelphia. J. F. Coleman was the engineer for this project and the mechanical engineering work was in charge of Walter Castanedo, Mem.Am.Soc.M.E. The guarantees for capacity and duty under given conditions are given in Table 2. This plant has not been tested.

RESULTS OF TESTS, DRAINAGE PUMPING PLANTS

The author concludes his paper with illustrations and descriptions of nine typical drainage plants upon which tests have been made, and gives results of the tests. In what follows herewith is a brief summary of the main results of these tests.

New Orleans Lake Shore Land Company, Citrus, La.: 48-in. Morris centrifugal pump; double suction pipes 38 in. diameter, 105 ft. long, with 90-deg. elbow and enlarged at end to 60 in. diameter; discharge pipe 31 ft. long; Corliss engine, Heine boiler.

Lift, 23 ft
Overall efficiency, engine, pump and piping, 22 per cent.

Later an electrically-driven plant was constructed, supplied by outside current, with two centrifugal pumps.

UNIT NO. 1, 120 R.P.M.	
Lift, 5.76 ft.	Lift, 6.54 ft.
Discharge, 77,800 gal. per min.	Discharge, 75,000 gal. per min.
Efficiency, 48.8 per cent.	Efficiency, 55.7 per cent.
UNIT NO. 2, 120 R.P.M.	
Lift, 6.10 ft.	Lift, 6.25 ft.
Discharge, 76,200 gal.	Discharge, 75,800 gal.
Efficiency, 49.7 per cent.	Efficiency, 51.75 per cent.

This unit was operated under unfavorable conditions.

Morris Centrifugal Pump, Second Lift, Neches Canal, near Beaumont, Tex.: Engine-driven centrifugal pump, discharge nozzle of pump 48 in. diameter, suction pipe 37⅝ in. Oil fuel used.

Head on pump, 9.99 to 10.23 ft.; average, 10.12 ft.
Horse power, average, 261.6.
Discharge, average, 69,300 gal. per min.
Pump efficiency, 70.2 to 72.5 per cent; average, 71.6.

Grand Canal Pumping Plant: 36-in. Lawrence Machine Company centrifugal pump; compound Corliss engine; rope drive; double suction pipes 24 in. diameter, enlarged to 34 in. at distance of 4 ft. from pump, and conical frustum at intake end; discharge into flume through vertical 20-in. pipe enlarged to 42 in.

Mechanical efficiency, engine, pump and rope drive, 69 per cent.
Assuming engine efficiency 92.5 per cent., and transmission efficiency, 95 per cent, efficiency of pump would be 78.5 per cent. This high efficiency is due in part to the enlargement of the suction and discharge pipes, thus reducing entrance loss and velocity head loss at entrance to flume.

Fidelity Land Company, Dalcour, La.: 24-in. Worthington Drainage Pump direct connected to 35 h.p. "Ingeco" engine using distillate.

Average lift, 5 ft.
Average delivery, 9602 gal. per min.
Fuel, 42 deg. Baume, at 86 deg. fahr.; weight, 680 lb. per gal.
Fuel consumption, 2.99 gal. per hr.

Whitelake Land Company, Florence, La.: Two 54-in. Worthington double suction pumps; direct connected to Corliss engines; suction and discharge pipes of approved diverging construction.

Revolutions per min., 91.1.
Indicated horse power, 186.2.
Discharge, gal. per min., 86,077.0.
Static head, 4.72 ft.
Efficiency, pump, engine and piping, 55.6 per cent.
Efficiency, pump and engine, 59.9 per cent.
Mechanical efficiency, pump and engine, 91.1 per cent.
Hydraulic efficiency, pump, 65.7 per cent.

Louisiana Meadows Company, Raceland, La.: 48-in. Worthington drainage pumps, combination of screw and centrifugal types; suction and discharge pipes enlarged at outer ends; pumps driven by two-stroke cycle, crude oil Snow engines, 14½ in. by 24 in.; fuel 27.4 deg. Baume at 60 deg. fahr.

Lift, 3.55 ft. to 4.96 ft.
Revolutions per min., 195.
Discharge, 60,050 gal. per min. at lower lift; 54,700 gal. per min. at higher lift.
Useful water horse power, 53.8 to 68.5.
Fuel consumption, 1.132 lb. (lower lift), and 0.887 (higher lift) per useful water horse power hour.
Fuel consumption per acre foot of water elevated one foot, 1.55 lb. to 1.12 lb.

Onishi Plant, Mackay, Tex.: 24-in. Worthington volute single suction centrifugal pump, direct connected to Buckeye compound condensing engine; machinery located in reinforced concrete pit; suction pipe 28 in. diameter, 148 ft. long; discharge pipe, 24 in. diameter discharging into tubes.

Lift, 37.23 ft.
Head on pump, 39.43 ft.
Discharge cu. ft. per sec., 32.5.
Indicated horse power, 230.4.
Useful water horse power, 137.2.
Water horse power basis of head on pump, 145.6.
Efficiency, engine pump and pipe, 59.5.
Efficiency, pump (estimated), 70 per cent.
Fuel oil, per useful water horse power hour, 2.82 lb.; per pump horse power hour, 2.66 lb.

Moore's Bluff Plant, Dayton, Tex.: This is a high lift plant. Worthington 36-in. volute pump, direct connected to cross compound condensing Corliss engine; 28-in. double suction pipes enlarging to 36 in. and to 5 ft. of intake; 36-in. discharge pipe enlarging to 48 in. diameter, extending up a hill at 45 deg. and discharging in a flume where it again enlarges; fuel oil, 19,347 B.t.u. per lb.

Lift, 55.88 ft.
Head on pump, 57.51 ft.
Average water pumped, 39,707 gal. per min.
Revolutions per minute, 173.4.
Indicated horse power, 793.44.
Useful water horse power, 557.50.
Efficiency, engine and pump, 72.3 per cent.
Efficiency, pump, 78.5 per cent.
Fuel oil, per indicated horse power hour, 1.378; per useful water horse power hour, 1.96.

Garwood (Tex.) Irrigation Plant: 36-in. Worthington volute pump, direct connected to compound condensing Corliss engine. This is another high lift plant.

Lift, 42 ft.
Head on pump, 43.51 ft.
Mean indicated horse power, 511.4.
Useful water horse power, 395.5.
Pump horse power, 409.9.
Discharge, 37,455 gal. per min.
Efficiency, engine, pump and piping, 77.1 per cent.
Efficiency, pump (assuming engine 92.5 per cent), 86.6 per cent.
Fuel oil per useful water horse power hour, 1.82.

The author states that this pump has made the best record of any he has tested. The lift was high and conditions favorable to a high efficiency. By way of comparison the following results are given:

Name of Plant	Pounds of Fuel Oil per Useful Water H.P-Hour
Neches Canal, First, Lift, Beaumont, Tex	2.09
Jennings Canal, Jennings, La	2.16
Sabine Canal, Vinton, La	2.29
Pierce Estate Canal, Wharton, Tex	2.84
Moore's Bluff	1.96
Garwood	1.82

From these figures it will be seen that the Moore's Bluff plant, which is the best of the list with the exception of the Garwood plant, uses more than 7 per cent more oil than the latter to do the same amount of useful work. The last two plants have shown the feasibility of pumping water to greater elevations than was thought commercially possible a few years ago. A properly designed steam driven pumping plant may be operated against a lift of 55 ft. at a cost that makes rice irrigation an attractive proposition, especially if the canal reaches a reasonably large acreage.

THE DESIGN AND TEST OF A LARGE RECLAMATION PUMPING PLANT

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Non-Member

UNTIL recently reclamation work along the rivers of the state of California has been accomplished more or less successfully in the small districts. During the last few years, however, there has been a very rapid development, with a decided tendency towards forming very large districts. To accomplish true reclamation it is necessary not only to exclude the flood, or overflow waters, but also to provide a drainage and pumping system which will insure the removal of all surface water, whether from rainfall or seepage, as fast as it accumulates. In the smaller districts the matter of drainage is not of very serious moment, but in a very large district the

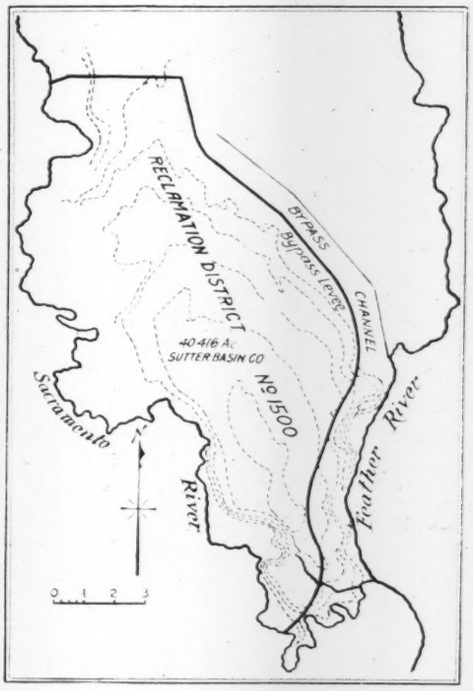

FIG. 1 SUTTER BASIN, RECLAMATION DISTRICT NO. 1500

amount of drainage water to be handled becomes enormous, and on account of the very great loss involved by a failure to remove this drainage water as fast as it accumulates, makes it imperative that the drainage and pumping system be designed in accordance with the best engineering practice. In this paper the writer will outline the problems involved and a solution of same in the case of one of the largest reclamation districts in the state of California, and which has resulted in the construction of the largest reclamation pumping plant in this country, having six 800 h.p. units.

In November 1913, the writer was given the following problem:—Given a reclamation district located at a definite point in the Sacramento Valley; proceed with the design and construction of a drainage pumping plant that, when operated in connection with a certain drainage and levee system, will insure the removal of all accumulated drainage water. No restrictions were placed on the writer and all details were decided on their respective merits. The district under consideration is known as Reclamation District 1500, created by act of the state legislature in 1911, and commonly called Sutter Basin. Its geographical location is shown in Fig. 1. Lying as it does between the Sacramento and Feather Rivers at their junction, it forms a large basin, with the lowest point nearly in the center. Its geographical location makes it subject to the full sweep of the flood waters of the above two rivers.

The District has an extreme length of approximately 19 miles, a maximum width of approximately 10 miles, and has an area of approximately 66,000 acres. The elevation of lowest point in basin is 19 ft. above datum, and maximum elevation of 30 ft. above datum. As the average maximum elevation of the flood waters at this point is approximately 39 ft. above

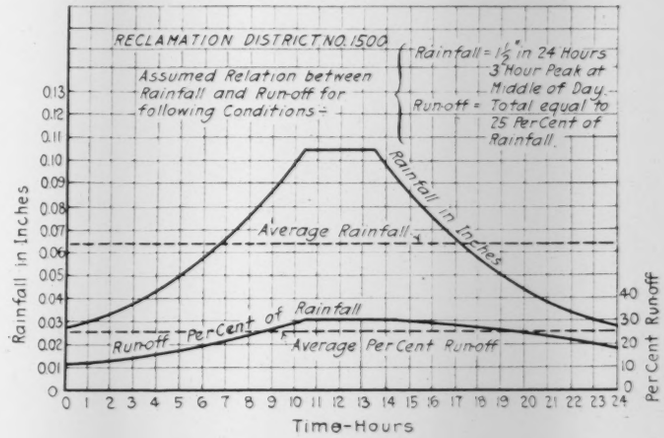
RECLAMATION DISTRICT NO. 1500
Assumed Relation between Rainfall and Run-off for following Conditions:-
Rainfall = 1½" in 24 Hours 3 Hour Peak at Middle of Day
Run-off = Total equal to 25 Per Cent of Rainfall
Rainfall in Inches
Average Rainfall
Run-off Per Cent of Rainfall
Average Per Cent Run-off
Per Cent Run-off
Time-Hours

FIG. 2 ASSUMED RELATION BETWEEN RAINFALL AND RUN-OFF

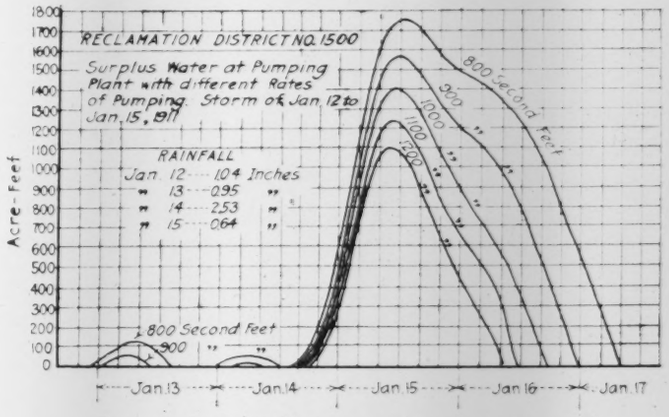

FIG. 3 SURPLUS WATER AT PUMPING PLANT

datum during the winter time, the entire district is under water with varying depth up to nearly 20 feet.

To reclaim this tract of land it is necessary to build levees around its entire circumference, about 70 miles, to exclude the flood waters of the rivers. The natural drainage of this tract is towards the center from the east and west and from north to south, terminating at the southerly end of the district, in what is known as Sacramento Slough, which empties into the Sacramento River near its confluence with the Feather. On account of this natural condition, it is obvious that this district should have only one drainage pumping plant, and its location should be near the point where the levees cross Sacramento Slough. This Slough has now been utilized as part of the main drainage canal of the district. This canal extends in a general northerly direction through the center of the basin.

The essential steps in the determination of the size and

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Presented at the San Francisco local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, on April 16, 1915.

character of the required drainage pumping plant, and its design, may be grouped as follows: (*a*) Determination of amount of drainage water to be pumped; (*b*) Pumping head; (*c*) Physical design of plant; (*d*) Construction; (*e*) Test and operation. The above steps will now be discussed in detail.

AMOUNT OF DRAINAGE WATER

As stated above, the amount of water to be handled by a reclamation pumping plant is made up of the run-off from rainfall and seepage through the levees, or any other underground channel. The former, while influenced by many quantities impossible to predict precisely beforehand, such as rate

FIG. 4 EXTERIOR VIEW OF PUMPING PLANT

of rainfall, duration of rain, state of land cultivation, etc., can, however, be approximated with a reasonable degree of accuracy. Since to produce true reclamation all drainage water must be pumped out of the district as fast as it accumulates, therefore the capacity of pumping plant will be determined by the *maximum* rate of accumulation of drainage water which has to be handled; otherwise a portion of district would become flooded. While the total amount of water to be handled may be made up largely of seepage, the maximum rate of accumulation is almost entirely determined by the run-off from rainfall, as explained later. It is, therefore, very essential that a very careful study be given to this phase, and as the maximum run-off may be expected at maximum rainfall, the essential point is to determine the conditions of run-off for this maximum rainfall.

RUN-OFF FROM RAINFALL

There has been in the past no actual observation of rainfall within this district. Therefore, the rainfall has been estimated from the two nearest points of record, Marysville, located at the east and north on the Feather River, and Knights Landing on the west, just across the Sacramento River, giving twice the weight of the Knights Landing readings over those at Marysville. As these readings are a matter of record they are not given here. From an analysis of the estimated rainfall thus made, the maximum rainfall for any of the years of record occurred on January 12, 13, 14 and 15, 1911, when rainfall was 1.04 in., 0.95 in., 2.53 in. and 0.64 in. respectively. Other periods of severe rainfall which might be mentioned here are, December 12, 13 and 14, 1906, where 0.6 in., 2.37 in. and 0.37 in. of rain fell respectively; also December 25, 26 and 27, 1906, with rainfall of 0.22 in., 2.01 in. and 0.20 in. respectively, and February 11, 12 and 13, 1909, with rainfall of 0.87 in., 1.40 in. and 0.69 in. respectively.

Rainfall equaling the above maximum values may be expected during any year, and it is not unreasonable to expect that at sometime they might be slightly exceeded. However, taking into consideration the fact that they are estimated values, that if the above maximum values as first given are used in connection with a conservative value of percentage of run-off, the result will probably not be seriously exceeded at any time. Therefore, the pumping capacity of plant has been determined from the estimated run-off resulting from the rainfall of January 12, 13, 14 and 15, 1911.

The yearly run-off from a district of this character can be estimated very accurately from the yearly rainfall, but in this case, since there are no storage facilities, we are concerned with the hourly run-off. It is a well established fact that the run-off varies with many conditions, among which is the rate and duration of rain. In this particular case, as will be seen, the hourly rate of rainfall will have a very material effect on the size of pumping plant. It, therefore, becomes necessary

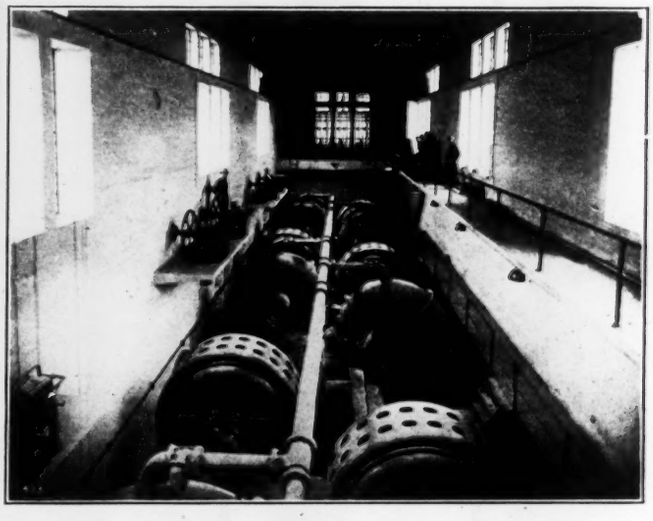

FIG. 5 INTERIOR VIEW OF PUMPING PLANT

to assign to the above rainfall a given hourly rate. After careful consideration of this point, Grunsky's method of estimating hourly rate of rainfall was adopted with some modifications. This, in effect, is that 50 per cent more rain falls in any one period than in the preceding period, that is, the ratio of fall for any period to the next of equal length would be 1 to 1½.

A further assumption was made that the rainfall for any one day started at a minimum value at the beginning and increased at the above ratio to a maximum, which lasted for three hours during the middle of the day and then decreased to a minimum at the end of twenty-four hours in the above ratio. This rate of fall for a rainfall of 1½ in. per day is shown in Fig. 2.

Having fixed the hourly rate of rainfall, the next step is to determine the run-off and rate of arrival of this run-off at the pumping plant. For purposes of this calculation the total run-off has been taken as 25 per cent of the total rainfall. The rate of run-off has been assumed arbitrarily to vary with rate and duration of rainfall, being greatest for greatest rate, and

also for equal rates of fall, being greater at the end of the days' rainfall than at the beginning. This varying percentage of run-off for the rate of rainfall assumed above is shown in Fig. 2.

On account of the large area of the district and its extreme length of 19 miles, it is obvious that the run-off from the extreme northern end will arrive at the pumping plant several hours after the rain has fallen. The drainage system of this district as laid out contemplates a very extensive system of ditches. These ditches have been designed for a certain velocity of water, and the area drained depending upon slope and character of soil, so that it may be assumed that as far

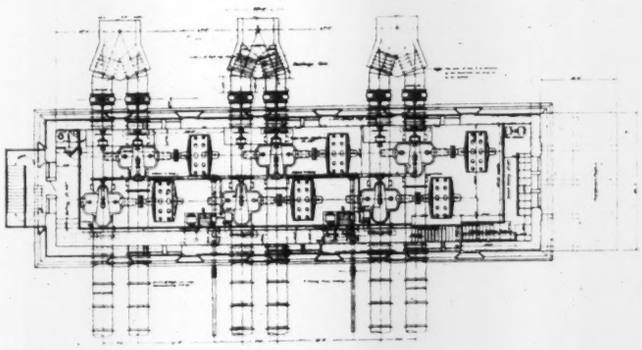

FIG. 6 PLAN OF PUMPING PLANT

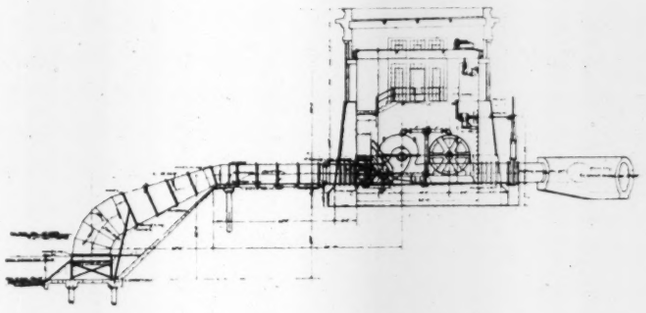

FIG. 7 ELEVATION OF PUMPING PLANT

as delivery of run-off water to the pumping plant is concerned, all ditches are equally effective. From an analysis of these factors, the district was divided into zones, or areas, such that the run-off from each zone might be assumed to reach the plant in a given time, taken in this case as one hour. That is, the run-off of Zone No. 2 has been assumed to reach the pumping plant one hour after run-off from Zone No. 1, etc. There is, of course, certain delayed flow of the run-off before it reaches the ditches, but as it is the same for all zones, its effect may be neglected as far as this calculation is concerned.

Applying the above method to the rainfall of January 12 to 15, 1911, as given above, and assuming different rates of pumping at pumping plant, the surplus water given in acre-feet, accumulating at pumping plant, above that pumped, is shown in Fig. 3. Fortunately, the main drainage canal is of very ample capacity, and it has in itself considerable storage capacity, provided that water is drawn down in canal before rain sets in. Assuming that pumps can draw the water down to 10 ft. above datum, and that no serious flooding takes until 20 ft. above datum is reached, the storage capacity between these two elevations is approximately 1150 acre-feet. Applying this value to the curves in Fig. 2, it is found that a pumping plant having a capacity of approximately 1000 to 1100 second-feet, should be sufficient for the purposes of reclamation, and for this district this value has been taken.

SEEPAGE

The amount of seepage water which might be expected in this district is very difficult to estimate. With the character of soil that occurs here, and assuming well constructed levees, such as are being built, it is reasonable to assume that the rate of seepage will not be a very great amount. In other parts of the state, where the subsoil is of a peaty nature, seepage water often reaches a considerable amount. There is practically no data available to base a substantial conclusion in this matter. It has been variously estimated by different engineers that under normal conditions, with subsoil as occurring in this district, that the seepage would average from ½ to 1½ second-feet per mile of levee, or from 35 to 100 second-feet.

The rate of seepage would be somewhat influenced by the

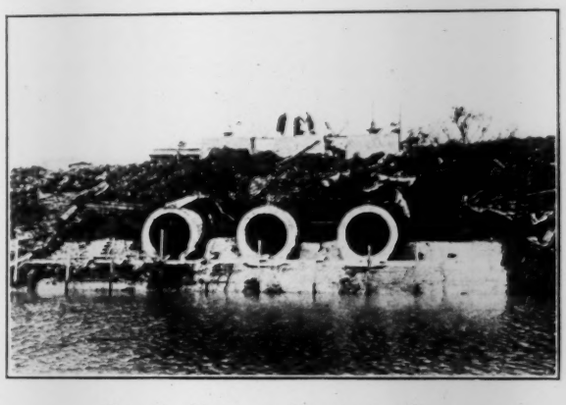

FIG. 8 VIEW OF DISCHARGE PIPES

height and duration of flood waters outside of levees. This seepage water is independent of the rainfall, and will have a tendency to be a more or less constant flow throughout the flood season, but its maximum value would be relatively small and therefore not have any material bearing on the maximum capacity of pumping plant; however, its effect on the amount of power consumed and the total amount of water pumped may equal or exceed that of the run-off from the rainfall. Hence, in determining the capacity of plant, seepage has been neglected.

PUMPING HEAD

The head under which the plant must operate is extremely variable. During the months of November and December, before there is any very great rise in the rivers, the head will be a minimum, and in this particular case will be about 10 ft. static. However, when the flood season occurs the plant will be required to operate under its maximum head. The calculation of the maximum flood plane is of very considerable moment, as not only does the pumping equipment hinge on it, but also the entire levee construction is based on the probable flood height. At the present time, with the district open to overflow waters, there was recorded this year a flood height of 39.2 ft. above datum. But with the completion of levee system, and the confining of the flood waters to a restricted channel, the flood plane will increase very materially.

On account of its bearing on the construction of the levee system, the calculation of the maximum flood plane was undertaken in very great detail, and very thoroughly, under

the able direction of the chief engineer of the District, Mr. George N. Randall, who, from many years' experience with the flood conditions of the Sacramento River, was able to bring a great fund of information and data to assist in determinations of this point. The problem was attacked from every conceivable angle. In general, however, the methods consisted primarily in determinations of the maximum flow of water through the By-pass and Feather River channels. The width of this channel being fixed and general slope known from surveys, having estimated the maximum flow, it is a comparatively simple matter to determine the depth of water, or, in other words, the maximum elevation of flood plane.

The data collected is too voluminous to present here, and is perhaps beyond the scope of this paper. The conclusions,

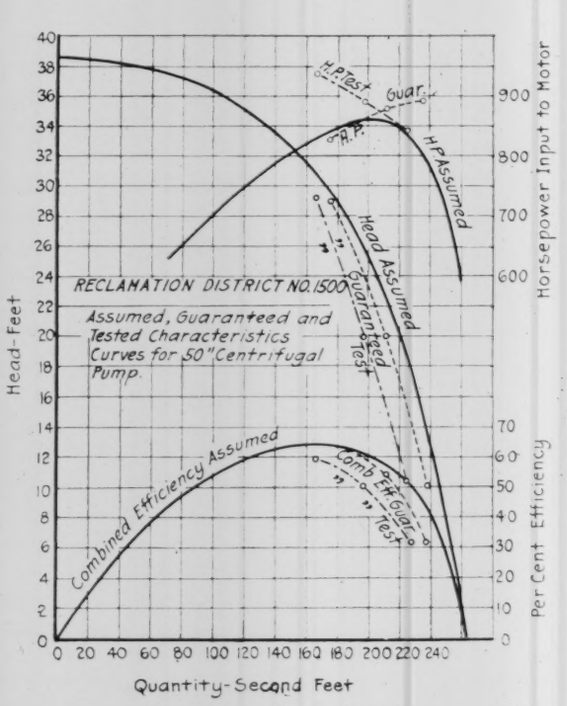
RECLAMATION DISTRICT NO. 1500
Assumed, Guaranteed and Tested Characteristics Curves for 50" Centrifugal Pump.
H.P. Test
Guar.
H.P.
H.P. Assumed
Head Assumed
Guaranteed Test
Combined Efficiency Assumed
Comb. Eff. Guar.
Test
Head-Feet
Horsepower Input to Motor
Per Cent Efficiency
Quantity-Second Feet
0 20 40 60 80 100 120 140 160 180 200 220 240
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
600 700 800 900
0 10 20 30 40 50 60 70

FIG. 9 RESULTS OF PRELIMINARY TEST RUN OF ONE UNIT

however, were that the maximum elevation of flood waters when confined to the By-pass channel would be approximately 42 ft. above datum, and this value is used in determining the maximum head of pumping.

While as a general rule the peak of the flood waters occurs from one to three days after the rainfall, there are conditions which might arise whereby this peak would arrive at the point of discharge of the pumping plant simultaneously with the arrival of the maximum run-off water at the suction sump of plant; therefore conservatism demands that the plant be designed to handle maximum amount of water against maximum head.

While the above quantities determine the capacity of plant, in order to obtain an estimated early consumption of power, the same calculation of quantity and head were made for each day of the winter season, and also for the six years of record, 1906 to 1912. These detail calculations are not presented here, the estimated power consumption for pumping run-off only being from 700,000 to 1,200,000 kw-hr.

With an elevation of discharge water level of 42 ft. above datum and elevation of water surface in suction sump of 16 ft. above datum, the maximum static pumping head is 26 ft. Allowing for an estimated friction loss in discharge pipes of 3 ft., the total maximum pumping load was taken at 29 ft. Therefore, in conclusion, the capacity of plant will consist of pumps that can handle 1000 second-feet against a 29 ft. head. With this determined, the only remaining feature is the physical design of plant.

PLANT DESIGN

The first consideration in the plant design is the motive power. In this connection electric motors, steam engines or turbines, and Diesel engines were considered. On account of the fact that the plant was readily accessible to three power companies, the Pacific Gas & Electric, Great Western Power Company and Northern California Power Company, this had a very great weight in forming the decision to use electric-motor-driven centrifugal pumps, it also having the

FIG. 10 GENERAL VIEW OF PUMPING PLANT

other great advantage of lower initial investment, although a little greater operating expense.

In order to select the size and number of pumping units, a number of plant layouts were made with four, five, six, seven and eight units, and after careful consideration, both of conditions to be met and manufacturers' requirements, a plant having six units, each a 50 in. centrifugal pump having a normal capacity of 175 second-feet against a discharge head of 29 ft., driven by an 800 h.p. electric motor, was selected as offering the most satisfactory arrangement and best economical design.

At this point a consideration of the advisability of using one or two speed motors was taken up. The use of a two-speed motor offers several advantages in a condition such as presented here of variable head. The two-speed motor, if properly chosen in respect to conditions, will produce a higher overall efficiency, which in turn means a lower annual operating cost. On the other hand, it has several disadvantages, as higher first cost of motor, increase in cost of building on account of requiring more space, and great multiplicity of parts and operating gear. After careful consideration of the various advantages and disadvantages, a final selection of the one-speed motor was made, as the saving in annual cost of operation due to a slightly greater overall efficiency, did not warrant the increased investment.

BUILDING

Inasmuch as the district would be flooded the first year after installing plant on account of non-completion of levees, and also as a protection against damage to pumps from flooding due to possible breaking of levee at high water, the design of pumping plant building becomes of perhaps greater importance than actual mechanical layout of pumping units. In designing the building, it must be so constructed that

its walls and floor slab will safely resist the water pressure due to floods, also sufficient weight must be present to prevent flotation.

The building as finally constructed is of reinforced concrete, the walls so designed as to withstand a depth of water on the outside of 18 ft. above floor level. This necessitated walls 4 ft. 6 in. thick at the base of the floor line. Under the above water pressure conditions the uplift pressure on the bottom of building amounts to nearly 5000 tons. This gives some idea of the problems that had to be faced—they are similar to those of dry dock construction. On account of the water conditions to be met with, there is no opening into the building below elevation 42 ft. above datum, or 18 ft. above the floor line. The building rests on a concrete pile foundation, approximately 300 25-ft. piles being used. No difficulties of any serious moment were experienced during construction.

PUMPING UNITS

On account of the problems to be met in the building construction, every effort was made in the pump unit layout to reduce the size of the plant. The writer believes that the layout finally selected offers the most compact layout consistent with good operating conditions. The units are dovetailed in such a manner that a minimum of space is required. Each unit is independent of the balance, having each a separate steel suction pipe and the discharge of each group of two pumps is brought together outside of building into a single pipe. There are three reinforced-concrete discharge pipes, 78 in. in diameter. After passing through the levee, each of these pipes passes into a valve chamber which has a large wood and steel swinging check valve and also a sluice gate.

On the suction sides of the pumps there are no valves of any character. On each discharge side there is located just outside the building a 50 in. gate valve, operated by a direct-current motor mounted on the inside of building for flood protection, and operated by means of a shaft passing through a stuffing box in the wall; the gate valves were placed outside to reduce the size of building. All units and motors operating the gate valves are controlled from the switchboard located in one end of the building. Priming pumps are installed in duplicate, each capable of priming any one pump in ten minutes. These pumps are of the wet vacuum type, and may also be used for removing any drainage water inside of building. One rather unusual feature is the installation of a storage battery for operating motors on gate valves. This was done so that the gate valves may be operated quickly if the main source of electric power should fail, and this feature has proven very successful.

Electric power is delivered to motors at 2200 volts from three 1500 k.v.a. 60,000 to 2200 volt, outdoor-type oil-cooled transformers. These transformers are mounted outside the building on a platform sufficiently high to be out of danger of flood water.

The total cost of this plant, exclusive of engineering, is approximately $170,000, of which the building, discharge pipes and sump represent $75,000 and the pumping machinery $95,000. Views of the plant are shown in Figs. 4 to 8 and in Fig. 10.

TESTS

The writer had hoped to give at this time results of final tests on units in this plant. However, the preliminary test run has been made on one unit and the results are presented here. These results are not to be taken as final, as the pump manufacturers are to make a slight change in runner, which it is expected will modify considerably the results of the preliminary test run.

The specifications covering the pumping machinery provided for the method of test. Guarantees of efficiency were made on the combined efficiency of motor and pump, also with all losses in suction pipe charged to the pump. The electrical input to the motor was measured by means of two indicating wattmeters. The discharge head on pump was obtained by means of a U-tube of water, the total pumping head being taken as the difference in level between the water in the sump and height of water shown in U-tube. The amount of water was obtained by means of a Cole & Flad pitometer, two right angle traverses being made on suction side of pump. Care was taken to eliminate errors on account of use of this instrument on the suction side. The combined efficiency was obtained for three different heads, 10, 20 and 29 ft., as provided in the specifications. The results of the preliminary tests on one unit are shown on the curves shown in Fig. 9. On this sheet are also shown estimated curves used by the writer in his original calculations, and also guaranteed values. It is expected that changes in runner, as proposed by manufacturer, will bring about a closer harmony between guaranteed and actual test results.

In the evolution of centrifugal and turbine pumps, no factor has played a greater part in obtaining increased efficiency than the study of the laws of the surface friction of fluids. This subject has been under investigation by the most eminent engineers for more than 100 years, and today the laws governing the velocity of flow for a particular fluid are tolerably well known. Experiments establishing a general relation applicable to all fluids and conditions of flow are not known, however, though it is known that such relations must exist. A knowledge of the relations which hold between widely differing viscosities and densities, with reference to main flow and also to secondary or induced currents, will be of great value. C. G. de Laval in *Am. Soc. C. E. Proceedings, Vol. XLI, No. 9.*

Notes, with numerous illustrations, analytical data, costs, descriptions of plants, etc., to indicate the trend in Europe of some of the important fuel problems that are conspicuously before the United States, are given in *Tech. Paper No. 123, U. S. Bur. of Mines*, by R. H. Fernald, Mem.Am.Soc.M.E. The subject matter is divided into *a*, utilization of high ash coals; *b*, use of wood refuse and other similar material; *c*, recovery of fuel from by-products; *d*, recent developments in the preparation and use of peat; *e*, results of low temperature distillation of fuels; *f*, possibilities of the slagging type of gas producer; *g*, use of powdered fuel.

The science of valuation is an interdependent mixture of law, economics, and engineering: Law, to establish the governing ethical principles; economics, to establish the criteria of value or monetary standards; engineering, to apply the general criteria of value to any given specific case in accordance with ethical principles.

Some of the problems of valuation are unsolvable on any definite mathematic basis. To solve the problem as to what is the value of property requires the most logical reasoning, involving legal, economic and technical science, and in addition to all, that very rare endowment known as common sense.—S. S. Wyer, Mem.Am.Soc.M.E., in *Bul. A. I. M. E., April, 1916.*

STEAM SAFETY VALVES

A Discussion of the Principles of Safety Valve Operation in the Light of an Extensive Series of Tests Leading to a New Development in Safety Valve Design

BY GEORGE H. CLARK,[1] BOSTON, MASS.

THE object of this paper is to place before the Society a record of the experimental work and conclusions drawn therefrom, of an investigation into the theory and design of a safety valve. Safety valves have been in the past, and are at present the result of cut and try methods, rather than a mechanism based on logical and fundamental principles. The theory which is here presented is believed to be general in its application, and original in character. In the course of the experimental work undertaken at least 50 valves have been built and tested, and during the course of the experimental work I have not tested, or seen in operation under test, a single valve of a design which is now on the market. Each valve built and tested has been for the purpose of proving or disproving a step in the theory which follows.

At a glance, it seems that the problem of the design of a safety valve should be a simple one, but when the facts are brought into line, the problem becomes increasingly difficult. All present day valves employ huddling or expansion chambers, although those best fitted to know the reasons for their use disagree as to the actual part played by such chambers in the action of the valve in which they are incorporated. This is one example of the apparent mysteriousness relative to the action of present day valves. It is hard for the engineering public to understand why it is not possible to increase the lift of valves in accordance with the demands of the day for high capacity valves, without endangering the boilers to which they are connected or the valves themselves, and it is probably true that this misunderstanding is due to the lack of reasonable explanations, in which those best fitted to know concur. The pros and cons of high and low lift valves have been discussed before this Society in great detail, and I believe that I am giving the consensus of opinion in this regard in the statement that high lift valves, so-called, produce more or less shock at closure which may injure the boiler itself, and is usually a serious factor in determining the life of the valve. The Boiler Code Committee of the Society has seen fit, in its recent report, to propose a limitation in the lift of safety valves of approved design, a fact which is evidence of the above statement.

A moment's consideration will show that increasing the lift is, except for changing the seat angle, the only available means of substantially increasing the relieving capacity of a valve of given diameter, and further consideration, when the tendency in steam boiler practice is taken account of, results in the conclusion that high lift valves must come into common use. The absolute necessity for high discharge capacity valves has led English designers to employ auxiliary pistons acted on by boiler pressure, and adapted to produce high lift. To us this seems an awkward method of solving the problem, when it is remembered that most producers of safety valves state that they can build high lift valves of the ordinary type. In spite of the economical and commercial advantage to be gained, such valves are not upon the market and are, in fact, frowned upon by both manufacturers and users.

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Presented at the Boston local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, on March 14, 1916.

SAFETY VALVE SPECIFICATIONS

Most specifications in force at the present day, both abroad and at home, are based either on grate area or heating surface, and are recognized by engineers to be misleading and entirely inadequate for present day practice. This fact is evidenced by the innovations contained in the report of the Boiler Code Committee, which bases the relieving capacity on the greatest possible amount of steam that can be generated and provides that valves shall take care of this maximum amount. There is nothing to be said in criticism of this standpoint, as experience tells us that every boiler plant will some day have to depend on its safety valves to prevent destruction, and that in this emergency they should not be found wanting. The difficulty of this method is the lack of capacity of valves of the present day to provide means for economically taking care of the situation.

I venture to say that the demands of the rules laid down by the Boiler Code Committee have not come home to the boiler users at present. Whatever the position of the boiler user, the basis of the specifications is absolutely right and just, and they distinctly put the real issue on the valve manufacturer himself. If it can be shown by one or a group of valve manufacturers that, after fulfilling all the other requirements incident to a proper safety valve, the lifts and consequent discharge capacities are well above those allowed by the specifications, then the table of capacities must be revised to meet the new conditions in order that true progress may not be blocked.

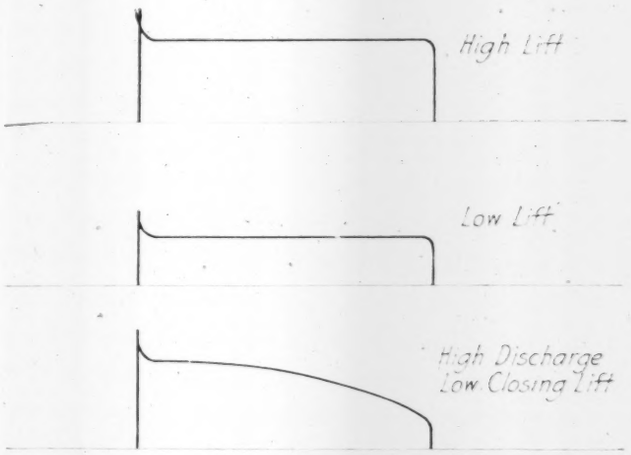
At this point it is necessary to cite a few examples of the workings of the proposed rules in order that the true status of safety valve practice may be illustrated. One of the most popular boiler units found in present day plants is the 500 h.p. water tube boiler, and, equipped with stokers, fans, and pressure regulators, this boiler represents current practice. In general this boiler is fitted for and equipped with two 4 in. valves on the drums, and one 4 in. valve on the pipe leading from the superheater. In general such valves are of the 45 deg. seat type, and reference to the table of capacities in the proposed rules allows us to determine the required equipment for this boiler. These boilers are run oftentimes at 300 per cent rating, and under these conditions generate approximately 45,000 lb. of steam per hour. If the boiler pressure be taken as 200 lb. gage, it will be found that with the maximum lift allowed in the table, the discharge capacity of one 4 in. valve is 9420 lb. per hour. This boiler will then require five 4 in. valves. Now the specifications state that should two or more valves be connected to a common base, the nozzle supplying the combination must have an area equal to the combined area of the valves connected thereto. Since most of this type of boilers have 4 in. valve nozzles, it will be found somewhat difficult to install the required capacity without extensive changes. Since the limiting size is 4½ in. diameter and since four of this size will be required, there is little to be gained in this direction, as all the connections are unsuitable without the same extensive changes.

The largest single boiler unit is a Stirling type boiler of 2356 boiler h.p. adapted to run at 210 per cent rating. A

simple calculation will show that the combined discharge capacity of the safety valves should be 148,000 lb. per hour. This installation under the rules would require eleven valves of the maximum size and maximum lift at 200 lb. gage pressure. The safety valves of a boiler of this size would probably be piped outboard, and under the proposed specifications this would require eleven separate discharge pipes. It is customary to set valves connected to the same boiler with a certain range of pressure between their respective popping points. If they are set 2 lb. apart, then the total range of pressure will be 22 lb. or slightly greater than 10 per cent of the working pressure. The rules require that the installation of valves must relieve the boiler with not greater than 6 per cent accumulation above the allowed pressure. It is true that this boiler is an extreme at present, but it does represent the tendency of present day practice.

IMPORTANCE OF DISCHARGE CAPACITY

In the development of boilers and accessory apparatus, the



FIGS. 1, 2 AND 3 DIAGRAMS OF LIFT CHARACTERISTICS

safety valve has become less of a working piece of apparatus and more of a safety appliance. Before the advent of stokers and in the days of hand regulation, either the ash pit doors or the safety valves were open all the time. Today we find ourselves providing a rule which calls upon the engineer to see that his valves are opened once a day at least to insure that they are in working order. It is clear, then, that the safety valve is called upon in the emergency only, not as a pressure regulator, and if this is the case, should not its discharge capacity be of fundamental importance?

The factors which tend to limit the discharge capacity of the ordinary type of valve when high lifts are attempted are the apparent impossibility of regulation and the shock produced at closure. The actual valuation of the shock produced at closure defies calculation for many reasons, but it can be shown experimentally that the height from which the disc drops to sudden closure plays an important part. The diagrams shown by Figs. 1 and 2 represent graphically the lift characteristics of high and low lift valves, a study of which shows that they are essentially alike in all characteristics, but that in high lift valves the distance through which the disc drops to sudden closure is much greater than in the low lift valves and actual experience tells us that the low lifts operate without shock, and that the high lifts are subject to that defect in greater or less degree. If this is the case, the logical solution would seem to be a valve giving a diagram like that shown by Fig. 3, in which the lift during the blowdown period gradually decreases to a small value before sudden closure takes place.

We are not vitally interested in the discharge capacities of valves during the blowdown period provided that high lift can be maintained at the popping pressure. If their discharge capacity is such that, after blowing, the blowdown period is finally reached, the emergency is taken care of, and the installation is safe. In order to produce a valve which will give the diagram shown in Fig. 3, it is necessary to keep the disc in equilibrium with the boiler pressure, while that pressure is being reduced and to explain the factors, it is necessary to go into some detail as regards fundamental theory.

RELATION BETWEEN DISCHARGE AND PRESSURE UNDER DISC

The first thing to investigate is the variation in pressure on the spring load area of the disc—in other words, the pressure which exists below the disc in advance of and during the period of blowing. By means of certain assumptions we can apply

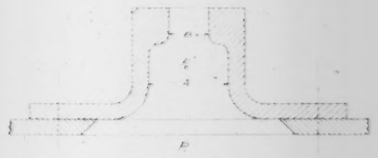


FIG. 4 REDUCTION IN AREA BETWEEN BOILER AND VALVE

the formula of flow proposed by Napier, and after the calculations are made they may be tempered by the actual conditions which exist, should they deviate from the assumptions.

Steam in the course of its passage from the boiler to the atmosphere encounters two reductions in area of passage, which affect the pressure under the disc, one at entrance to the valve or the nozzle, and the other at the seat. The existent area conditions may be graphically represented by Fig. 4, in which the reduction of area from boiler to valve is denoted by the section at A and over the seat by the section at B. The edges of the passage which form the approach to the section at A are rounded to a radius equal to the diameter of the passage in order that the formula that we shall use may fit the case at hand. Let P_1 represent the boiler pressure, P_2 the pressure under the disc, and then assume that by some means the area at B can be changed as desired. When flow is established and conditions have become constant, the weight of steam passing the section B is the same as that passing the section A, and if the weight passing B is varied, that passing A goes through the same variation. Now the pressure P_2 depends on the weight flowing and the pressure P_1. Assign a constant value to P_1, say 200 lb. absolute and by means of the following formula, calculate the pressure P_2 with different weights flowing. So long as the discharge capacity by B is less than that at A, the formula

$$W = 0.029\, a \sqrt{P_2(P_1 - P_2)} \text{ holds.}$$

This formula when P_1 is assumed to be constant may be written:

$$P_2 = \frac{P_1}{2} \pm \sqrt{\frac{P_2}{4} - \frac{W^2}{(.029a)^2}}$$

after the quadratic equation has been solved.

Assume now for an actual case, that the diameter at A is 2 in., giving an area 3.1416 sq. in. and that P_1 is equal to 200 lb. absolute boiler pressure. Then calculate different values of P_2 with different weights flowing. These values of P_2 may

be plotted against the weights and the curve shown by Fig. 5 will result. This curve is interesting since it represents quantities which may be arrived at by calculation only, and which must exist. Its significance is as follows:

With a safety valve of 2 in. nominal diameter and adapted to discharge a certain weight of steam, the pressure under its disc may be found from the curve as follows: Suppose its discharge is 6 lb. per sec.; then the points C and D are located and the pressure under the disc may be read. It is clear then from this curve that the pressure under the disc varies as the weight of flow varies, and that for valves of low lift the

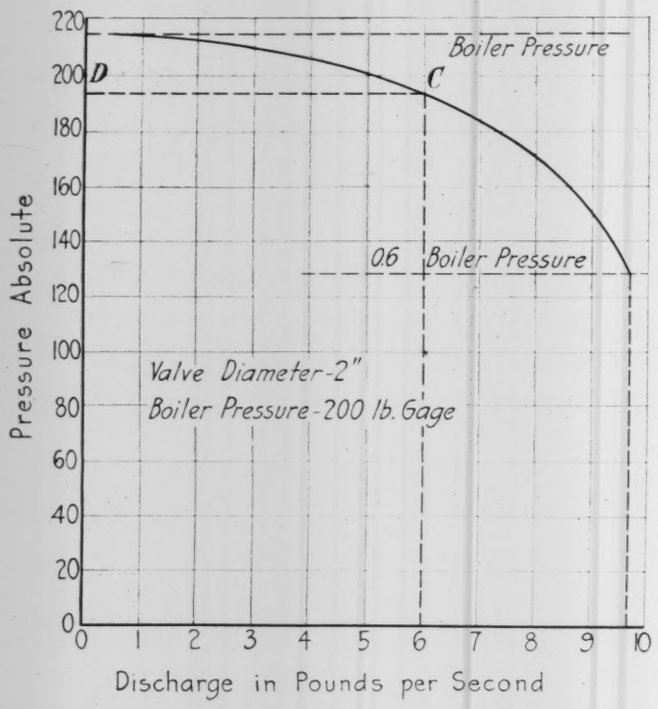


FIG. 5 RELATION BETWEEN PRESSURE UNDER DISC AND WEIGHT OF STEAM FLOWING

reduction of pressure is not great, but that for high lifts it increases rapidly. This curve is discontinuous when the pressure under the disc reaches a point where it is equal to 0.6 the boiler pressure, under which conditions the area at B has become equal to that at A; the pressure P_2 is the minimum possible, and to all intents and purposes we have a standard orifice, so-called, the characteristics of which are shown by Fig. 6.

Our only assumptions up to the present are the neglect of friction and the rounded edges. It is clear that friction and square edges will tend to increase the drop in pressure, since both tend to reduce the discharge capacity of A, and it also follows that maximum capacity is not available with square edges at A. In other words, the full advantage of the hole in the boiler is not available unless this hole has rounded edges.

There results from the further consideration of the curve in Fig. 5 a simple explanation of why a safety valve disc settles back after the first sudden pop. Since the reduction of pressure on the disc does not take place until the valve is open or until flow is established, the lifting force is, at opening, that due to full boiler pressure, and the instant flow is established this is reduced and the disc must necessarily settle back to a position of equilibrium. The design of a valve must then incorporate means to provide lifting force outside the seat area, to make up for the reduction of upward force on the load area due to drop in pressure over and above that necessary to compress the spring.

In any safety valve there are three factors which affect the rate of flow over the seat, which are characteristics of the seat itself. They are: *first*, vertical lift; *second*, seat angle, and *third*, the contour of the passage which approaches the seat. The flat seat is adapted to open the largest area per unit of vertical lift, and hence should be employed, all other things being equal. Since the approach to a standard orifice makes the throat sectional area 100 per cent efficient, the characteristics of such an orifice should be employed. Professor E. F. Miller, of the Massachusetts Institute of Technology, was first to round the edges of a safety valve in order to increase the efficiency of discharge per unit of lift, and in so doing took a long step in the direction of high safety valve efficiency. The valve shown in Fig. 7, in which the standard orifice, or better, its practical equivalent, is incorporated, follows the theory proposed by him several years ago. The full benefit of the standard orifice would be available, regardless of the type of lip provided, if the passage area from the seat outward increased, but to produce a high lift valve the maximum available pressure between the lips consistent with maximum discharge must be used.

STEAM FLOW AS AFFECTED BY SHAPE OF ORIFICE

A consideration of the pressure conditions within a standard orifice, of which Fig. 6 is an example, will give valuable information. In this type of orifice the area of each section after the throat section, is equal to that at the throat section, and it has been found that at the throat section and at each section of equal area thereafter the pressure is very closely equal to 0.6 the boiler pressure, and that the back pressure into which this orifice discharges has no effect on either the weight discharged or the existent orifice pressures unless this back pressure exceeds 0.6 the boiler pressure. If it does exceed 0.6 the boiler pressure the discharge capacity is reduced and the pressure throughout the orifice is increased. With the orifice of a shape shown in Fig. 8, but of equal throat sectional area, the weight discharged is the same as before, but the pressure after the throat section varies inversely as the area.

It follows from the above consideration that in order to produce maximum pressure between the lips there must exist at full lift an equality of area at each section outward from the throat of the orifice which is located at the seat. Since the effective disc diameters are constantly increasing, the effective lift must be reduced as the passage is lengthened. This can be done by giving the passage an upward slope, as is shown by Fig. 9, which illustrates graphically the reduction of effective lift with increasing diameters such as D_1 and D_2 at which the vertical and effective lifts are measured.

If a valve of the above characteristics is constructed and blown, it will be found to have an extremely high lift, and the opening of such a valve is so sudden as to be truly explosive. A very large percentage of the pop lift is sustained if the popping pressure is held constant, and when such a valve starts to blow down the lift gradually decreases during the blowdown period until a certain point is reached, where the pressure becomes such that the valve disc drops suddenly to closure. This construction will produce a blowdown which is likely to be a third of the boiler pressure and forces its designer to incorporate means of regulation which

will give a small blowdown without interfering with the capacity, or other features of valve action.

REGULATION FOR WARNING AND BLOWDOWN

The question of adjustment presents the real difficulty in safety valve design. Means for regulation should in general perform their functions with as little effect as is possible on the lift and, per unit of lift, should produce no effect on the discharge capacity. Other than lift, the two functions to be controlled by regulation of the variations in lifting force are warning and blowdown. A valve which chatters or vibrates at the instant of opening, or sizzles at that time, shows a lack of lifting force at low lifts, and one which shows an excessive blowdown demonstrates that the lifting force at low lifts is too great to allow of closure, and it follows that the requirements of warning and blowdown are somewhat combative. If it is possible, means should be provided for making, in so far as is possible, the means adopted to regulate one independent of the other. Blowdown is an absolute necessity on the spring loaded type, due to the existence of lifting force outside the spring chamber, and it is clear that attempts to reduce the blowdown will tend to decrease the lift and relieving capacity. In general, the real secret in the design of a perfect safety valve lies, not in the production of excessive lifting force, but in controlling and adjusting it: the action of a valve is dependent, not on the quantity of lifting force, but on variations of lifting force with discharge capacity and pressure.

DESIGN OF NEW VALVE

Fig. 10 shows a valve which has means for adjustment which are based on the production of variable lifting force as stated above. The two annular rings shown at *A* and *B* carry on their upper surfaces curves which approximate in shape the curve of the disc. The inner ring *A*, which I choose to call the warning ring, is threaded upon the base of the valve just outside the flat seat and carries, threaded upon it, the ring *B*, which is adapted to control the blowdown. These rings may be lowered away from the disc, or given what I choose to call initial clearance.

Now it is clear that if both of these rings are lowered, an extreme distance, when the valve tends to open no lifting force will be available. If the ring *A* is raised to a position near the valve disc, a lifting force will be provided which will depend, *first*, on the pressure produced between it and the disc, and *second*, on the extent of the disc area on which this pressure acts. As was shown in the discussion of the standard orifice, the pressure depends on the area of the passage and the area in the valve is a function of the initial clearance and the shape of the curve. These factors are built into the valve to produce the desired result, which is to provide lifting force at small lifts to overcome excessive warning, and it has been found that with the proper shape of ring, on its initial clearance, depends the warning of the valve. Since this warning ring alone produces only small lifts, it has no appreciable effect on the blowdown.

Now as the blowdown ring *B* is raised from its lowest position, there is a tendency to build up pressure between it and the disc when the valve is open, which tendency increases as the disc is approached. If a reasonably large clearance is left, it is clear that this ring produces almost no lifting force at low lift, since the area of the passage along this ring is large in comparison to that over the seat, and it follows, also, that as the disc lifts the effect of this initial clearance on the area of the passage becomes less and less as lifting continues. This can be illustrated by a simple calculation. Suppose that, measured at the extreme outside edge of this ring, the initial clearance is 0.03 in. and that the angle at this point is 45 deg.; then if the disc lifts 0.1 in. in a vertical direction, the height of the passage over the seat will be 0.1 in., and at the extreme edge the increase in passage height perpendicular to the curves will be 0.07 in., since with a 45 deg. angle the vertical lift is only seven-tenths effective—so that the total height of the passage is 0.1 in., the same as that over the seat. Suppose now that lifting continues; the area at the edge of this ring gradually approaches that over the seat and can be made to become equal to it by proper design at any chosen lift. It is clear then that for all of the initial clearance of the rings, we have at full lift gotten back to the area conditions of a standard orifice.

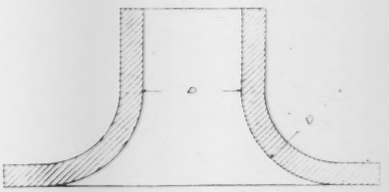


FIG. 6 PRESSURE CONDITIONS FOR "STANDARD ORIFICE."

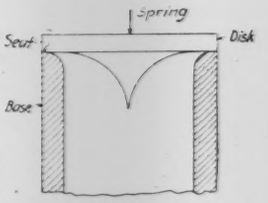


FIG. 7 VALVE INCORPORATING STANDARD ORIFICE EQUIVALENT

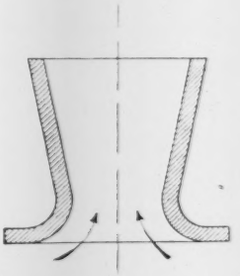


FIG. 8 PRESSURE VARYING INVERSELY AS AREA

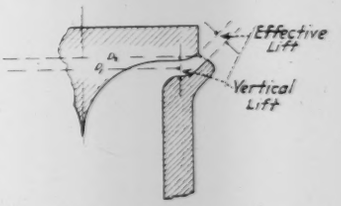


FIG. 9 VALVE WITH MAXIMUM PRESSURE BETWEEN LIPS

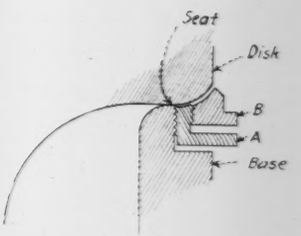


FIG. 10 VALVE ADJUSTABLE FOR VARIABLE LIFTING FORCE

Tests of this valve prove the value of this method of regulation in that all the requirements of practice are afforded by it for all of the high lifts. Any one sufficiently interested can lay out a valve of this type, and he will find that if the characteristics of the spring to be used are known, he can calculate with reasonable accuracy the lifting force at any lift and also an approximate value of the total lift. In calculations of this nature, the reduction of pressure on the spring load area, as previously explained in this paper, must be taken into consideration.

DIAGRAMS SHOWING PERFORMANCE OF EXPERIMENTAL VALVES

I have with some difficulty succeeded in getting some diagrams from valves under service conditions which, I believe, show in detail the results of the methods of regulation which

are employed. Fig. 11 shows a photograph of the arrangements of the valves for testing. The tests from which the diagrams were secured were carried on at the power plant connected with the new buildings to be occupied by the Massachusetts Institute of Technology.

One of the regular 4 in. valves was removed and a Y-base substituted in its place; the regular 4 in. was then placed on one of the branches and on the other was placed a special by-passed gate valve, and finally, on top of this, the valve on test was connected. Under the above conditions the valve on test was well above 3 ft. higher than the top of the drum. Those experienced in safety valve action will realize that this height is apt to seriously affect the action of the ordinary valve. The recording apparatus used consisted of a clock motion adapted to turn a chart once in 15 minutes. Bearing on this chart was a pen rigidly connected to the spindle of the valve and adapted to leave a record thereon

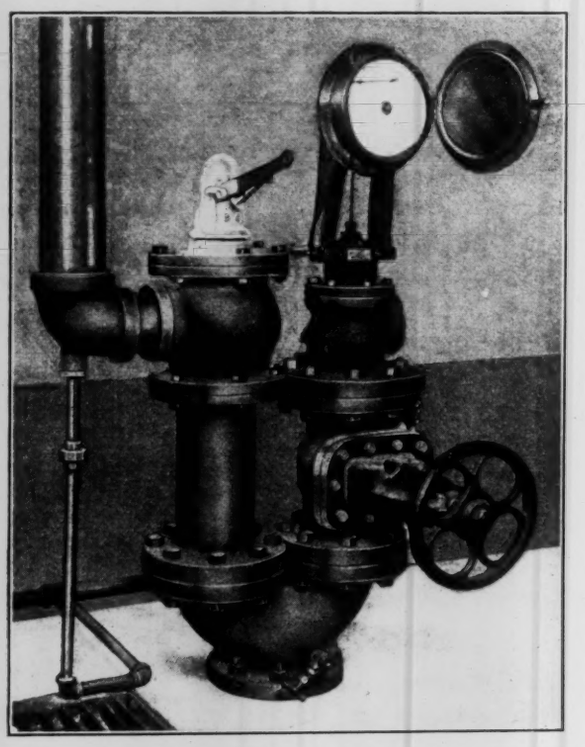


FIG. 11 VALVE ARRANGED FOR TEST

of lift with respect to time, the lifts being multiplied by a ratio of approximately four to one.

Fig. 12 shows a chart of the performance of a valve with a 2½ in. seat. This valve was blown at 150 lb. gage boiler pressure and showed, under the existent regulation, 5 lb. blow-down and almost no warning. In order that it may be clearly understood, it has been transferred to a diagram having rectilinear axes, on which is plotted the scale of lifts which resulted from the calibration of the recording lift gage with an accurate micrometer. In Fig. 13 the sudden pop lift is shown at *A*, and the corresponding sustained lift at *B*. The variations in lift at the point *B* are further evidence of the readjustments of pressure which determine the pop and sustained lifts, an idea of which may be gained from the theoretical considerations previously stated in this paper. The discharge capacity of this valve was such that the popping pressure was not maintained, and the curve from *B* to *C* shows the reduction in lift, which in this type always corresponds to a reduction in boiler pressure. At *C* the valve closed suddenly with less than half its initial sustained lift prevailing.

In other words, the drop lift of this valve, which is numerically 0.09 in., is about equal to that of a low lift valve, while its discharge capacity at popping pressure is nearly twice as great as regards lift, and is even more when seat angle and efficiency are taken into account. This diagram shows the action of the valve when adjusted to give action somewhat similar to that to be found in some types of valves now procurable, and is in a good many ways ideal. Attention is called to the smoothness of the curve between *B* and *C* as evidence of the equilibrium between lift and boiler pressure existent as the boiler pressure is reduced.

Fig. 14 shows precisely the same valve with its outside or blowdown ring lowered slightly. This diagram is, like the one preceding, a photograph of the actual diagram, and has not been transferred to rectilinear axes because of the difficulty in showing the fluctuations in lift. The section of the curve at *A* shows the pop and sustained lifts as before. From *B* to *C* is shown the gradual reduction of lift corresponding to decreasing boiler pressure, until the point *C* is reached, where the disc suddenly falls from a reasonably high lift to a much lower one. This action is due to the large initial clearance of the blowdown ring, which throws it out of action entirely when the lift value at *C* is reached. The fluctuations in lift at the point *C* show the lack of equilibrium at this point in the action, which results finally in the drop to the lower lift. At the lower lift, represented by *D*, all the supporting force is that due to the inner or warning ring.

The downward slope of the curve from *D* to *E* shows the tendency of the valve to decrease its lift with decreasing pressure and closure would doubtless have taken place at *D*, had not the fans been started at this point in an attempt to force the pressure back to the popping pressure. The section from *E* to *F* shows an increase in lift corresponding to the increase in pressure. The fluctuations in lift during this period show the tendency of the blowdown ring to come into action, it being prevented from doing so only by the lack of pressure. The fans were shut off without orders at *F*, and the valve immediately blew down and closed with 0.04 in. closing lift at *G*. If we suppose the diagram to have been completed by closure at *D*, as would have been the case without the attempted accumulation, this diagram would then represent the action of a high lift valve with a closing lift less than that obtainable from any low lift valve of ordinary design. That this action can be and is continually repeated by valves of this type is a fact to which every one who has been a witness of the blowing of this valve will testify. To those who have heard such valves blow no diagrams are necessary.

It was decided after the two preceding diagrams were secured to change to a smaller valve of lower discharge capacity, under which the pressure could be regulated as desired. It is my purpose to bring out by the three diagrams which follow the faculty this type of valve has to respond, under ordinary conditions of regulation, to accumulated pressure above the opening pressure. The new Boiler Code rules, if put into force, will allow 6 per cent accumulation of pressure, and I wish to show by the diagrams what advantage may be taken of this accumulation.

Fig. 15 shows a chart taken from a 2 in. valve in which the pressure was not allowed to accumulate. The low closing lift in comparison to the sustained lift is to be noted. Fig. 16 shows the same valve with an accumulation of pressure over the opening pressure of 4 per cent. This is under the

same regulation conditions as the next preceding chart. The substantial increase in lift and corresponding discharge capacity is to be noted, together with the same closing lift.

In Fig. 17 the valve was regulated to give a low sustained lift, and was then given the full 6 per cent accumulation. It is clear that the lift at *B* is more than 100 per cent greater than that at *A*, so that the discharge capacity at 6 per cent accumulation is more than 100 per cent greater than that at the opening pressure. The low closing lift is to be noted as before. The blowdown on this valve was about 2 lb., so that this chart was made between a maximum pressure of 159 lb. and a minimum pressure of 148 lb. The new Boiler Code specifications rate valves on their sustained lift at the popping pressure, and so it is clear that with this type the basis is amply safe.

In presenting the diagram (Fig. 18) for consideration I believe that I am showing a safety valve which is absolutely new, both in conception and results. It has been the aim of safety valve designers to produce a valve which relieves a boiler with an action which is smooth and containing as few sudden fluctuations in pressure as is possible. The Boiler Code Committee recognized the capabilities of standard valves to respond to accumulated pressure by incorporating the 6 per cent accumulation rule. The ideal safety valve for practical purposes is, I believe, one in which a reasonably low lift is maintained at the popping pressure, but one which will on the slightest accumulation respond with an extremely high lift to take care of the emergency. If a low lift is available at the popping pressure for ordinary relief, a low blowdown may be incorporated, the condition imposed by absolute safety being that at slightly above the popping pressure, the lift will have increased to such an extent that any possible emergency will be taken care of.

Fig. 18 shows a diagram from a valve which produces the above action, and is what may be called a second opening valve. Many of this type have been built, and it has been found that with the proper regulation of rings, all valves having two rings will produce this action in modified form. Imagine, first, one of the ordinary type blown with the outside ring removed. This would result in a low lift and a very low blowdown. Now suppose that the blowdown ring is in place, but that it is given such a large initial clearance that the valve will act, provided that it has sufficient capacity to relieve the boiler, exactly as before, but if it has not the required capacity the pressure will accumulate and the increase of lift resulting with only the inner ring in action will finally bring the outer ring into action, and a second pop will occur. This pop will result in a high lift, with corresponding high discharge capacity, and the valve size may be proportioned to give the required safety.

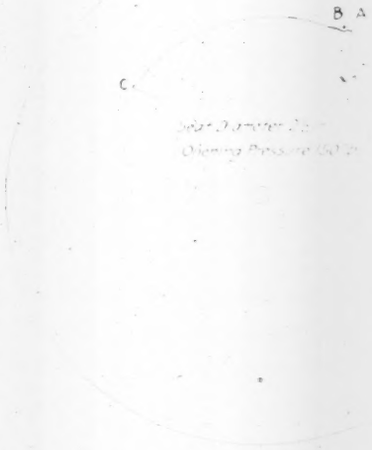


FIG. 12 PERFORMANCE OF 2½-IN. EXPERIMENTAL VALVE

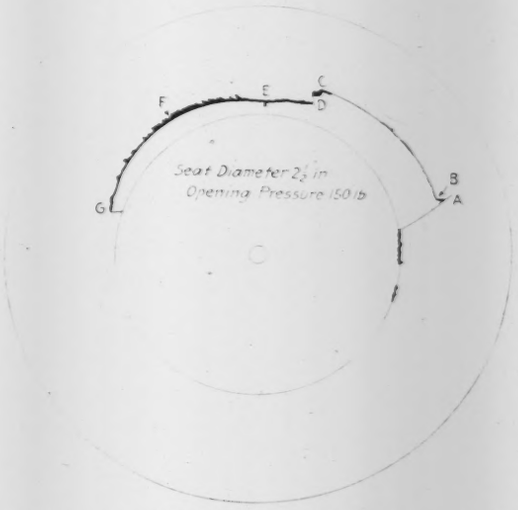


FIG. 14 VALVE OF FIG. 12 WITH BLOWDOWN RING LOWERED

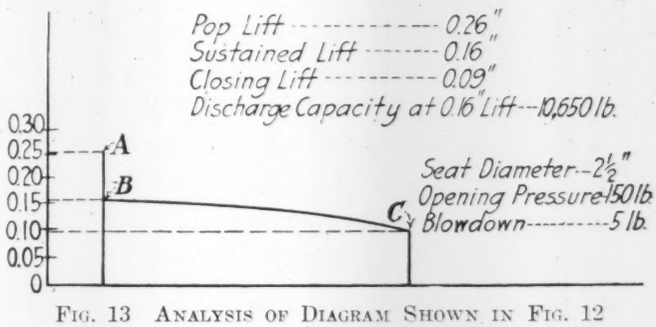


FIG. 13 ANALYSIS OF DIAGRAM SHOWN IN FIG. 12

That this action can be accomplished in actual practice is shown by the diagram in Fig. 18, which resulted from the action of a 1¼ in. valve on a boiler, or rather boilers, of sufficient capacity to produce the required accumulation. The first pop and sustained lifts are shown at *A*, the sustained lift being very low. The increase in lift between *A* and *B* finally results in the second pop, shown at *B*, which is the result of accumulated pressure. Between *B* and *C* the lift gradually falls as the pressure is reduced, until at *C* the outside ring goes out of action and the disc drops to a low lift, which is at the given pressure just sustainable by the inner ring. As the pressure is reduced the lift decreases, and after a slight blowdown the valve closes at *D* with a very low closing lift. This valve had a seat diameter of 1¼ in. and lifted at its highest sustained point about 0.11 in. This lift was the result of about 4 per cent accumulation, and the calculated discharge capacity is 5100 lb. per hour, which is approximately 170 boiler h.p.

FEATURES OF DESIGN

Careful design will allow of bringing the second pop down very near the first one, and the limits of regulation may be so built into the valve by limiting the possible up and down

motion of rings, so that this second pop will always come within a given range of pressure. This type of action has many advantages to recommend it. The absence of sudden excessive changes in relieving capacity and the low lift at closure are evident from the diagram. It is clear that if a boiler had two valves of this type, the second might be set to blow at a pressure corresponding to the point *O* on the diagram, so that the two valves would be able to handle the boiler at all ordinary times without the second pop, but in the case of emergency both would rise to the second pop lift. The installation would then be essentially a low lift installation, but would have all the advantages of high lift in the case of emergency.

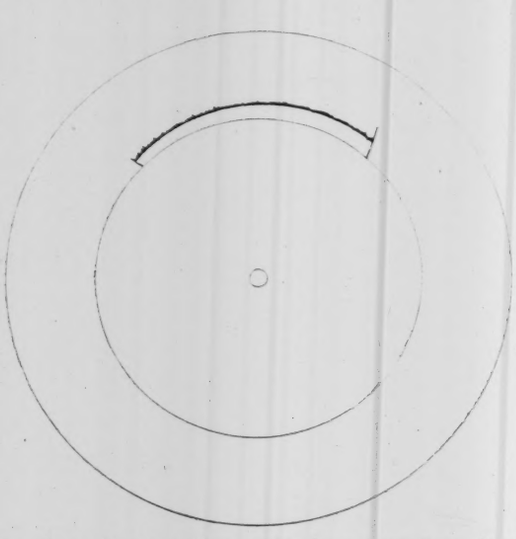


FIG. 15 2-IN. VALVE: SUSTAINED LIFT AND LOW CLOSING LIFT

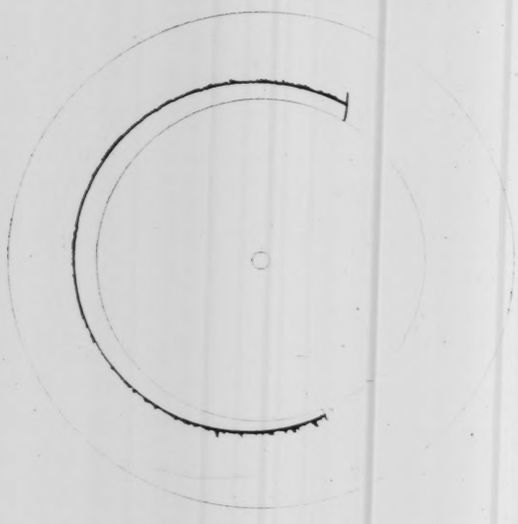


FIG. 16 2-IN. VALVE: PRESSURE ACCUMULATION BETWEEN OPENING AND CLOSING

TABLE 1 RESULTS OF DISCHARGE TESTS ON 2 AND 2½-IN. VALVES

Valve Diameter	Opening Pressure	Blowing Pressure	Percentage Accumulation	Discharge in Pounds per Hour	Efficiency	Lift
2.5″	150 Lb.	158.8 Lb.	5.86 %	17,325	99.43 %	.252
2.5″	200 Lb.	212.9 Lb.	6.44 %	16,892	78.88 %	.238
2.0″	200 Lb.	203.4 Lb.	1.7 %	10,176	101.57 %	.145

Above pressures are by the gage.

DISCHARGE TESTS

In the course of my experimental work very few discharge tests could be run, since most available plants have no means of measuring the water used. Three tests were run at An-

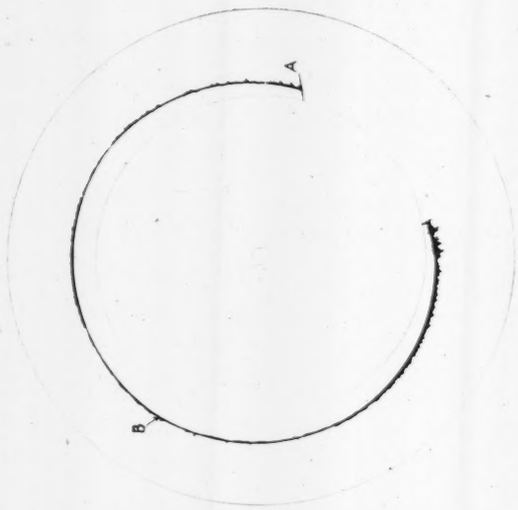


FIG. 17 2-IN. VALVE: LOW SUSTAINED LIFT WITH PRESSURE ACCUMULATION

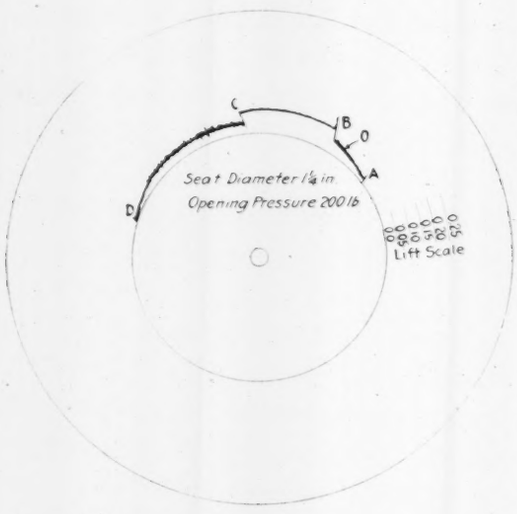


FIG. 18 A "SECOND OPENING" VALVE

napolis, Md., at the United States Naval Experiment Station, the results of which are useful in this paper only in so far as they establish the fact that the efficiency of the standard orifice type is so nearly 100 per cent per unit of lift that the accepted formula used will not show accurately the deviation from the above efficiency. Three capacity tests were made, two with a seat diameter of 2½ in. and one with a seat diameter of 2 in. Two of the tests were run at the regular, 6 per cent over-pressure common to Navy practice. The results reported by the station are shown in Table 1.

The test in which the efficiency fell off to 78.88 per cent is reported by them to be a mistake which, after the test, was impossible of correction, so I think that it is fair to assume

that we may accept the results as evidence of the fact that the discharge efficiency is so nearly 100 per cent that for ordinary calculations the efficiency may be neglected.

It is always interesting to compare the results obtained from any piece of apparatus with those which we know to be theoretically possible. In the case of safety valves the full opening valve serves as a convenient basis of comparison, in that its capacities may be calculated without reference to the type of valve used. If we attach a standard orifice to a boiler we have then the most efficient way of discharging steam, and this on a basis of throat diameter may be characterized as the full opening valve.

In column 1, Table 2, are shown the capacities of full opening valves of several diameters figured directly from Napier's formula. Column 2 shows the discharge capacity of valves of the same diameters as read from the table in the recent A.S.M.E. Boiler Code. I have assumed that these values represent standard conservative practice. Column 3 shows the discharge capacity of the type of valve which I have described, and is the result of calculations involving the lift as measured from the diagrams at the popping pressure.

It seems reasonable to believe that the spring load of a safety valve is to some extent a measure of the shock at closure, which may be expected. Since all valves of the same

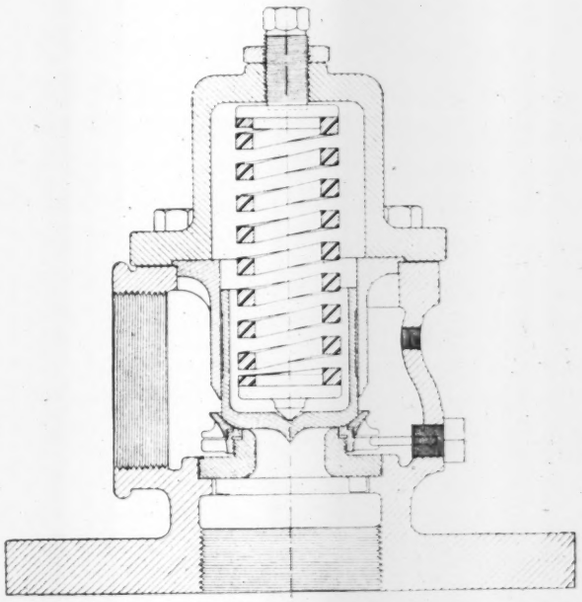


FIG. 19 STEAM SAFETY VALVE OF APPROVED DESIGN

diameter have approximately the same spring load, some other basis than diameter must be chosen for comparison. Discharge capacity is the first requisite in all valves, and so the spring load has been calculated per 1000 lb. of steam discharged per hour. Column 4 shows the spring load per 1000 lb. discharge of full opening valves, which is, of course, constant. Columns 5 and 6 show the same quantity calculated for A.S.M.E. valves and for the proposed type. Columns 7 and 8 show the percentage of full opening attained by the two available types.

There is reason to believe that we shall soon have boilers which will operate at 600 lb. pressure. Consideration of some of the values given in this table is interesting in this connection. A 4 in. valve set at 600 lb. pressure will have a spring load of approximately 7540 lb., or about 3½ tons. Now if a 2 in. valve can be constructed to give twice the lift of the 4 in., it will have the same discharge capacity, but its spring load will be only one quarter as great, or 1885 lb. In other words, the discharge capacity varies as the first power of

TABLE 2 CALCULATED CAPACITIES OF FULL OPENING VALVES

Opening Pressure 150 Lb. Gage

Nominal Valve Diameter	1″	1½″	2″	2½″	3″	3½″	4″
1 Discharge capacity of a full opening valve	6,660	14,900	26,600	41,600	59,900	81,600	106,500
2 Discharge capacity of A.S.M.E. valves (from table)	904	1,625	2,529	3,613	5,419	6,954	8,670
3 Discharge capacity of proposed type (from tests)	...	...	5,310	10,640	...	...	...
4 Spring load of (1) in pounds per 1000 lb. discharged	17.7	17.7	17.7	17.7	17.7	17.7	17.7
5 Same for A.S.M.E.	131	120	185	204	196	208	218
6 Same for proposed type	...	...	88.5	69.2	...	...	...
7 Percentage of full opening attained by proposed type	...	...	26.6	25.6	...	...	...
8 Same for A.S.M.E.	13.6	10.9	9.51	8.67	9.05	8.50	8.15

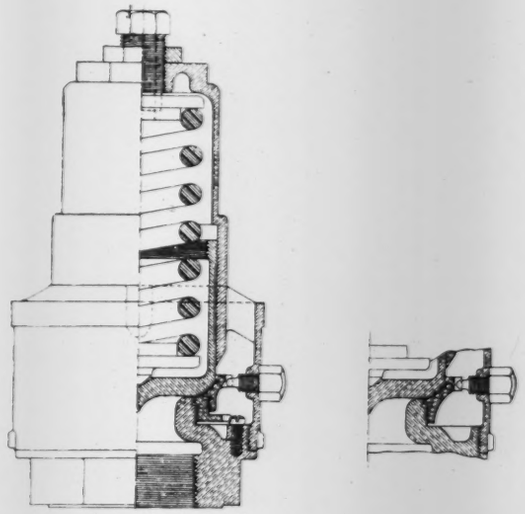


FIG. 20 LOCOMOTIVE VALVE OF APPROVED DESIGN

the diameter and the lift, but the spring load, which is independent of the lift, increases as the square of the diameter. It seems clear from this that high pressure boilers will of necessity require small-diameter high-lift valves.

This table shows the net result of the development in spring-loaded safety valves, and serves to emphasize the opportunities which may be grasped by the designer.

The question of the effect of back pressure in the casing of a safety valve has been much discussed. It has been said that it may operate in two ways to reduce the discharge capacity. *First*, the effective lifts may be reduced, and, *second*, it has been held that back pressure reduces the efficiency of discharge of the orifice. If any of the disc area is exposed to back pressure, the lifts will be reduced to some extent, but consideration of the theory of flow through an orifice, and particularly a standard orifice, brings out the fact that as long as the back pressure in the casing is less than 0.6 the boiler pressure, the discharge of the orifice is not affected.

The discharge capacity tests made some years ago by Mr. P. G. Darling went some distance in establishing this fact, although no general conclusions were drawn. It remained for a section of a Committee of the American Society of Refrigerating Engineers, with Professor E. F. Miller as chairman, to establish this fact beyond question. In refrigeration

installations long discharge pipes are required, and the back pressure built up in them as a result of pipe friction produces so much back pressure that either the ordinary type of valve is useless or its discharge pipe must be of an excessive size. The experimental work resulted in a valve which was so constructed as to take advantage of back pressure to increase its lift without in any way having its discharge capacity per unit of lift reduced. This valve is due to the ingenuity of Mr. F. L. Fairbanks of the Quincy Market Cold Storage and Warehouse Co., and has been adopted as the standard in Massachusetts.

EFFECT OF BACK PRESSURE

The possibility of back pressure operates to reduce the discharge pipes to reasonable sizes in spite of their length. There are many economical advantages to be gained for steam users by a valve which will operate without harmful effect of back pressure. *First*, the sizes of discharge pipes may be reduced, and, *second*, several valves may be connected into a common discharge pipe.

EXAMPLES OF THE NEW VALVES

Fig. 19 shows a complete view of a valve which has the above advantages. In the first place, valves of high

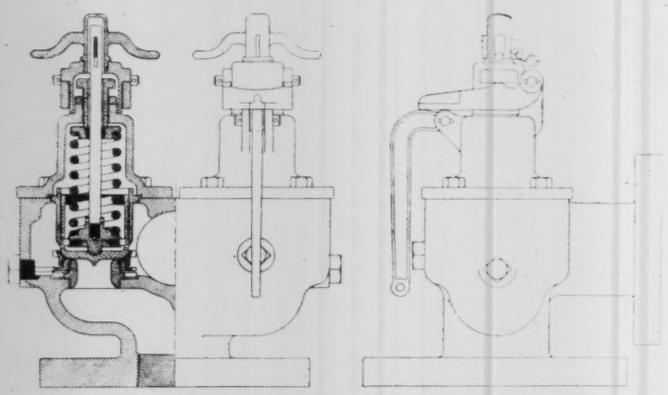


FIG. 21 MARINE VALVE OF APPROVED DESIGN

lift, and by that I mean higher lift than any of those obtainable at present, must be guided from above, as guides in the base will cause too great a drop in pressure on the disc area. In this view the disc is made in the shape of a hollow piston, which is guided by a cylindrical sleeve which encloses the spring chamber. The fit existent between these is extremely loose, and no attempt is made to prevent leakage by the disc. This loose fit insures that the disc will not bind because of expansion or contraction between the members due to temperature changes, and is long enough in relation to the diameter of the disc so that it will never cock. Its looseness alone insures that the disc will come to a uniform bearing on the seat, and it has been found that under no conditions of back pressure has the leakage by it been sufficient to produce pressure in the spring chamber, which is always fitted with a vent. With this type, the back pressure may be built up to nearly 0.6 the boiler pressure without hampering the discharge capacity in the least, and since the back pressure is a result of the effective opening of the valve, it has no effect whatever on regulation, if it is brought about by the means shown.

In the case of duplex or triplex valves having a common discharge pipe, the opening of one will tend to open the other, due to the exposed area outside the seat and the impossibility of back pressure acting downward on the disc. It must be understood that the commercial types of valves which are shown in the following illustrations are not dependent on back pressure for any part of their action, but are in every case adapted to work with it, without harmful effect. Fig. 20 shows a locomotive valve of approved design, and Fig. 21 the proposed marine type of exceedingly large capacity.

Having shown a valve in which there is substantial increase in discharge capacity over those in use at present, and having demonstrated that this may be accomplished with lower closing lifts than are now the rule, attention is called to a possible improvement in this type. It will have been noted by this time that in all the types shown, the passage turns upward from the seat region, and it is also clear that so far as the area conditions go it might as well be turned downward. If it is turned downward, the area conditions will remain constant, as illustrated in Fig. 22, but there will be available as lifting force a factor which would act upward on the disc, and which is commonly known as a jet action. Some few valves of this type have been constructed, and the results gained have been convincing of their possibilities. Enormous lifts have been attained with the same absence of shock at closure as is the case with valves herein described. The problem has been by no means solved, but advances have been made in a direction which tends to indicate that it will be solved finally, and will result in enormous discharge capacities per inch of valve diameter, with the same efficiency per unit of lift. It is clear

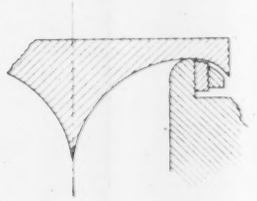


FIG. 22 VALVE WITH "JET ACTION"

from a consideration of the diagram that the force due to jet action will not be destroyed by back pressure, as the velocity of the issuing jet of steam is a function of the orifice pressure, which pressure is not affected by the back pressure.

In closing this paper, attention is directed to the fact that this valve is not essentially a high lift valve. It may be designed to give low lifts as well as high lifts, and is easily adaptable to the proposed specifications. It will, of course, under the specifications, benefit, by reason of its flat seat, by a discharge capacity about 30 per cent greater than the 45 deg. seat now in common use.

I have shown that it is possible to produce a valve of high lift as regards discharge capacity and low lift as regards the shock at closure. This one feature alone removes the most serious objection to high lift. It is clear that for all of the reasonably high initial lift the valves have a marked faculty to respond to over pressure. Finally, high lift valves must come into general use as the safety requirements in boiler practice must be more economically met than is the case at present. It is distinctly the province of the experienced and unbiased engineer to lay down the rules that will govern future safety valve installations, but in determining the rules the valves must be considered on a basis of discharge capacity and action rather than lift.

THE PRACTICAL CHEMISTRY AND MODERN MANUFACTURE OF PORTLAND CEMENT

BY GEO. P. DIEKMANN,[1] MASON CITY, IA.

Non-member

WHILE the Portland cement manufacturing industry has grown from an output of a few hundred barrels per year to about 100 million barrels annually, and while the mechanical part of the manufacture has undergone many changes, the installation of improved machinery having almost revolutionized the former art of making the cement, the chemical process in itself is carried out in the same way, based on chemical laws and definitions laid down by the investigation and work of Fuchs and Vicat, two distinguished scientists of the early part of the last century. Of course, the advanced knowledge of chemistry and the researches of eminent men have given us more and truer knowledge of the chemical composition of cement, and in order to throw more light and awaken more interest in research, a prize has been offered by the Prussian Government for the best essay on the constitution and hardening process of hydraulic cements, and efforts are renewed to solve this much disputed problem.

Portland cement is a hydraulic cementing material with not less than 1.7 parts by weight of lime to 1 part of soluble silica plus alumina and iron. The lime necessary to produce Portland cement is found as limestone called calcareous matter, and the silica, alumina and iron are found in clay, called silicious matter; the calcareous and silicious materials are mixed in proper proportions and burned to incipient fusion at a temperature of about 2600 to 2800 deg. fahr. and the resulting clinker ground, to which 3 per cent of gypsum is added to regulate the setting time. Portland cement should not have more than 1.75 per cent sulphuric acid, which is equivalent to about 3 per cent calcium sulphate or gypsum, and not more than 4 per cent magnesia, although these specifications vary in different countries.

Chemically Portland cement is a salt composed of acid and basic constituents of such a composition that none of the bases are unsaturated. The main elements are silica, alumina and iron, known as the acids, and the lime and the magnesia are known as the bases. When limestone and clay have been intimately mixed and ground together to an impalpable powder, this then represents the mechanical mixture of acid and basic constituents, or what is the same, the silicious and calcareous materials. In subjecting this mechanical mixture of limestone and clay to the influence of heat at about 2600 to 2800 deg. fahr., the mechanical mixture is converted into a chemical mixture or compound, and limestone and clay exist no longer in their original form, but are converted into an entirely new chemical compound, a clinker, called tri-calcium silicate.

Various theories are advanced on the chemical composition of cement. According to Zulkowsky, there are existing two isomorphous compounds of the di-calcium silicate, the non-ortho active modification, the ortho silicates, the active modification and the basic meta-silicates. The meta-silicate is considered a strong hydraulite, having hardening properties in contact with water. The ortho silicate has no hydraulic properties and disintegrates. In other words, silica, lime, alumina and iron must be present in such a ratio that certain chemical action is produced.

According to Le Chatelier, whose work has long been considered the modern theory on cement, cement is a tri-calcium silicate. Professor Michaelis recently advanced the colloid theory, which might give an entirely new view on the constituents of cements. Clifford Richardson made a very thorough microscopic examination of cement clinker and his studies are very interesting. According to these theories, the total basic constituents of any cement expressed in equivalents should not be greater than three times the total acid constituents expressed in equivalents. According to Michaelis, the composition of the cement should be such that the ratio of the acid constituents to the basic constituents shall be from 1.8 to 2.2 times larger by weight. This formula is the one most used and enables the composition to be judged from the analysis very quickly.

In Portland cement each element performs a certain function, and therefore the elements should have a certain ratio to each other, as follows:

Lime to silica.....	2.8:1 minimum;	3.2:1 maximum;
Alumina to iron.....	2.5:1 minimum;	3.5:1 maximum;
Iron to alumina.....	2.0:1 minimum;	3.0:1 maximum.

The chemical composition of Portland cement is very uniform and is usually as follows: silica, from 20 to 23 per cent; alumina, from 5 to 8.5 per cent; iron oxide, from 1 to 4 per cent; lime, from 60 to 64 per cent; magnesia, from 0.5 to 3.5 per cent, and sulphuric acid, from 1.5 to 2.5 per cent.

There are certain formulae for the calculation of the proper proportion of each raw material in relation to the others according to chemical composition and physical nature. One of the most convenient which is used is a formula according to C. Shoch by which the desired ratio can be determined according to the analysis of the materials which are calculated on the total silicates containing silica, alumina and iron. However, no matter what formula might be chosen, the Portland cement raw mixture contains usually from 42 to 43 per cent lime and 20 to 21 per cent silica, or a ratio of 2:1; this may sometimes be as low as 1.8:1 and as high as 2.2:1.

Portland cement contains usually from 5 to 8 per cent alumina. With an increased amount of alumina the cement becomes quicker setting, and if the alumina content reaches about 9 per cent, the cement becomes very quick setting, due to the formation of a tri-calcium aluminate. If alumina is present in quantities exceeding a certain limit it is considered detrimental, as it not only produces a quick setting cement, but has a greater expansion power, especially if hardening takes place in sea water or water containing alkaline matter. The aluminates are parts of a cement which are most easily acted upon by certain salts contained in sea water, forming water soluble compounds which in time destroy the cement.

Iron in a cement combines with lime and acts as flux similar to alumina in lowering the fusing point between the acid and basic constituents. Iron will give cement a darker color. Alumina might be replaced by iron giving an excellent cement for marine work. In fact, there are now manufactured in Germany iron Portland cements which are claimed to be superior to ordinary Portland cements for sea water construction.

The effect of magnesia on cement is still a matter of investigation, but all agree that a large amount of magnesia is detrimental to cement. It is of so much more danger than other constituents as the expansion power of magnesia will occur long after setting. The general specifications call for not more

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[1] Chief Chemist, Northwestern States Portland Cement Co.

Presented at the Minnesota local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS on February 10, 1916

than 4 per cent magnesia, while the German specifications allow a limit of 5 per cent. Candelot in his investigation stated that magnesia produced the same effect as free lime. In recent years the many accidents occurring in construction where magnesia cements have been used have drawn attention to this question. Magnesia cements give very good results in tests, and masonry made with these cements shows desirable solidity sometimes during several years, but after a certain time swelling begins to manifest itself, and with such intensity that nothing can resist it. Candelot stated that a rod of magnesia cement 1 m. long was found to elongate 26 mm. in three years. Dykerhoffer stated, after very thorough research work, in which he studied the effects of magnesia, that when magnesia is added to the raw material or substituted for an equivalent portion of lime, it causes a decrease in strength in the resulting cement if present in a proportion greater than 4 per cent. Cracking occurs only with 8 per cent magnesia or more.

It is known that magnesia compounds become hydrated much more slowly than calcium compounds, and this is evident as although concrete consisting of calcium silicate and aluminate will harden and set in a proper manner, cement containing magnesia either in combined form or as free magnesia will, due to the slow hydration after setting, undergo changes and molecular movements, causing expansion and cracking. The natural cements contain usually from 16 to 22 per cent magnesia, but here the magnesia has no injurious effects as in Portland cement. The trouble lays in the burning, as while Portland cement raw mixture is burned at a high temperature to effect incipient fusion, forming a very dense clinker, in a natural cement mixture only a moderate heat is applied to drive off the carbon dioxide. The resulting clinker is soft and the magnesia is hydrated here very quickly; the hard clinker obtained with this process is picked out and not used.

The amount of sulphuric acid in a Portland cement should not exceed 1.75 per cent, but according to the German specifications 2.5 per cent is allowed. The presence of sulphuric acid in a cement is due to the addition of calcium sulphate, which is added in the form of rock gypsum or burned plaster before or after grinding the clinker. Portland cement clinker is more or less quick setting, and, in order to retard or regulate the setting time, a small amount of gypsum is added. The amount depends on the composition of the raw materials—usually from 2.5 to 3 per cent is added.

Portland cement clinker usually contains about 0.1 to 0.4 per cent of sulphuric acid due to the sulphates in the raw materials, which are mostly converted by the high heat to volatile acid and driven off. A small amount of this acid is also due to the ash from the coal, which becomes part of the cement. If the burning or fusion takes place in a reducing atmosphere, the sulphates will be converted to sulphides, forming mostly iron and calcium sulphides, which will again be oxidized to sulphates. The small amount of calcium sulphate added to cement retards the setting time.

When cement is mixed with water chemical action takes place at once, according to Le Chatelier. The hardening process is due to a deposit of inter-locking crystals from a supersaturated solution, part of the water entering into chemical combination. There are two distinct chemical actions which take place, the setting or hydration and the crystallization or hardening process. The process of setting is due to the formation of aluminates of calcium, developing a certain degree of heat, but the addition of calcium sulphate prevents quick hydration by forming sulphate of aluminate of calcium, which hydrates very slowly without developing heat.

Along with the hydration the hardening process is beginning very slowly. The tri-calcium silicate is decomposed by the action of water to mono-calcium silicate and calcium hydrate. The process of crystallization begins very slowly, and as time goes on the crystals become closer interlaced, forming a denser body and attain a stone-like character, called hydraulic character, and it is this process which makes Portland cement such a high grade hydraulic mortar. If once formed, no action of the elements can disturb its increasing crystallization, and as Portland cement is the binding medium in concrete, any suitable aggregate will become embodied and form an unseparable bond of natural stone.

Portland cement develops in the hardening process about 40 per cent of its total strength in the first 24 hr., 60 to 70 per cent in 7 days, 80 to 85 per cent in about 30 days, and it will attain its maximum strength in about 6 to 12 months, depending on the season of the year. This explains why a cement of 24 hr. is not as strong as at 7 days, and at 7 days not as strong as at 28 days.

There are several processes by which Portland cement is manufactured, the wet process, the semi-wet process and the dry process. In this country almost 95 per cent of the total product is made by the dry process. The production in this country has reached 92,000,000 barrels annually.

One of the most modern Portland cement mills has been recently erected at Mason City, Iowa, by the Northwestern States Portland Cement Company. The annual capacity of this plant is about 2,000,000 barrels. In it are indicated the many changes and improvements that the Portland cement industry has undergone, by the adoption of economical machinery, etc. The plant at Mason City is the seventh erected according to the Cowham system.

The materials used at Mason City are limestone and clay, which are found in almost perfect composition in the vicinity. The quarry, which is only a few hundred feet away from the plant, has a limestone averaging about 97 per cent pure carbonate of lime, and many acres of it are owned by the company. The physical characteristics of this quarry are a very important feature. It has not only horizontal seams, but vertical seams at right angles to the others, and the seams are so close that the rock is in reality a multiplicity of small cubes, and very little blasting is necessary to tear them asunder.

A large steam shovel with a 3-yard dipper is used in loading this rock in side open cars that are hauled by a Shay locomotive to the plant. The stone is dumped into a receiving hopper of a gyratory crusher, which crushes the rock to a 4 in. cube size, and from here it is elevated to the top of the crusher building and again crushed by two small crushers to cubes about 2 in. and finer. The stone then passes into a set of rolls, which crushes it to about ½ in. size and finer. The crushed material is next discharged into the bottom run of a 24 by 32 in. McCaslin conveyor which encircles the stone drying, stone crushing and stone storage building like a belt. The stone storage building has a capacity of about 30,000 tons of stone. The top run is located in the monitor of the building, and the bottom run is located in a tunnel under the storage pile. The conveyor permits of delivering the stone directly from the rolls to the dryer bins, or into the storage building.

As it is necessary to dry the stone before further reduction in size is made, this is done by two rotary stone dryers into which the stone is fed from the stone bins by Gates oscillating feeders. Each of these dryers consists of a fire-brick-lined cylindrical steel shell, 6 ft. diameter by 60 ft. long, mounted on two sets of carrying mechanisms. They are set on a slight slope, with the feed end a little higher than the discharge end;

and the furnace is located at the lower, or discharge end. The heat comes into intimate contact with the particles of stone as the dryer has shelves in it which raise the stone and shower it through the heated air and gases passing through the dryer.

From the dryers the stone is elevated and discharged into eight steel bins, from which it is discharged by means of feeders into Krupp ball mills. These ball mills take the output of the crusher above described and reduce it to coarse grit of which 50 per cent will pass through a 100 mesh sieve. This mill consists of a drum of a diameter about double its length, filled with 5000 1-lb. steel balls, and the lining is made up of over-lapping steel plates which form steps or shelves on the inside. This drum revolves at a speed of about 26 r.p.m.

The clay fields are located about $1\frac{1}{2}$ miles southwest of the plant. No stripping is necessary as the clay is suitable directly beneath the grass roots. A specially designed plow drawn by a traction engine is used to plow this clay to the depth of about 1 in., so that the air and sun can get a chance to dry it out. The clay fields are kept higher in the middle than at the edges in order to have easy drainage.

The clay is gathered by means of a specially designed gathering machine on scrapers (revolving cylinders), each drawn by a team of horses, which load automatically. When loaded the team is driven over a bridge under which the clay track runs and the clay is dumped automatically through an opening into side-dump cars. When a certain number of cars are loaded the train is hauled to the plant and up onto a trestle, where the cars are dumped in a few seconds. The clay is then discharged, by means of a belt, into clay pans, where the grinding of the clay takes place. From here it is raised into an elevated bin, from which it is fed into the rotary clay dryers, which are similar to the stone dryers. After drying, the clay goes either to the clay storage room or to the mixing station into a steel mixer alongside the stone mixer. The clay storage has a capacity of about 15,000 tons of clay. There is also another large clay storage building at the clay fields, holding approximately the same amount of this material.

In the meantime, while these materials are being prepared, samples have been taken at every step at certain intervals and tested at the laboratory, and the chemist, knowing the composition of the limestone and of the clay, is now in position to direct the proper amounts to be mixed to obtain the proper raw mix. The ground stone and the finely divided clay are stored in adjoining bins of steel, and steel spouts lead the materials through shut-off gates to steel hoppers mounted on scales. There are two sets of scales, each of which is so arranged that the weighman can see the poise but cannot tamper with the weights, as the scale beams are in a box which is locked and the key held by the chemist on watch; the adjustment of these scales is tested very often by the chemist. The stone is weighed first and then the clay is run in on top of the stone—approximately 9000 lb. of the two materials is weighed per batch.

After passing through a rotary mixer this material is conveyed to Allis-Chalmers tube mills for a finer grinding and mixing. These tube mills are steel cylinders 5 ft. in diameter by 22 ft. long, supported at each end by trunnions, and filled about one-half full with flint pebbles imported from Denmark, which are about the size of one's fist. The mixture is ground to a fineness such that about 97 per cent will pass through a 100 mesh sieve.

The raw mix, now prepared to its necessary fineness, is conveyed and elevated to the kiln building, where the raw mixture is calcined, and after all the carbon dioxide is driven off, the acid and basic constituents are fused, forming tricalcium silicates. The fusion takes place at about 2800 deg. fahr. The clinker, as the fused mixture is now called, drops from the kilns into a pit and is conveyed to the clinker cooling station. The kilns are similar in their construction to the stone and clay dryers mentioned heretofore, except that they are larger. These large cylinders, which are constructed of sheet steel 9-16 in. thick and lined with fire-brick, are supported at a slight incline from the horizontal by means of rolled steel tires, each of which revolves at about one-half a revolution per minute on four heavy cast steel rollers mounted in pairs on a rocker. Each of these kilns weighs, with its load of fire-brick and charge of mix, approximately 175 tons.

A large amount of coal is used for fuel in these rotary kilns, which after being dried and powdered in suitable grinding machinery to a fineness of about 97 per cent through a 100 mesh sieve, is conveyed to steel hoppers in the rear of the kiln building, and then fed through pipes into the lower ends of the revolving cylinders and blown with a pressure of 4 oz. per sq. in. through 5-in. pipes.

The cooled clinker is next conveyed and elevated to the Kent mill building, where the clinker is reduced to the size of fine sand. This fine clinker passes over a series of screens separating the coarser clinker from the fine clinker. The fine clinker goes on to the gypsum station, while the coarser is conveyed back to the Kent mill for regrinding. The finely ground clinker passes into a hopper having a capacity of five barrels, to which a weighed amount of gypsum is added. There are two of these hoppers, to allow feeding and discharging alternately. By this process the addition of gypsum is uniform at all times, as the clinker is weighed and the gypsum weighed also, insuring perfect uniformity.

The clinker with the addition of gypsum is then elevated and conveyed to the finish tube mills, which are similar to the raw mix tube mills. Here the clinker is ground to the desired fineness, which is on the average of about 96 to 97 per cent through a 100 mesh sieve. Tests of fineness of the cement are made from each mill every hour before the cement enters the warehouse. At this point samples of the cement are delivered to the laboratory each hour for the general tests of fineness, setting time and soundness. The warehouses in which the finished cement is stored have a capacity of 600,000 barrels.

After the cement has been tested for the necessary tests already mentioned, with the addition for tensile strength, the cement is then discharged from the warehouse bins into a conveyor running in a tunnel underneath the bins and elevated to bins above the packing machines, where the cement is packed in bags ready for shipment. Samples are taken during the loading of each car of cement and tested again at the laboratory before the car leaves the yards. The samples of cement are kept on file for six months. Perfect records of shipments and tests are kept in the laboratory, where they can be referred to.

The entire building equipment of the Northwestern States plant covers an area of about 40 acres of ground, and the buildings on the plant proper are arranged in a unique order, so that the material always advances from the crushing end through the various departments until it arrives at the packing room, where it is loaded onto the cars. About 1,600 carloads of machinery, materials, etc., of construction (exclusive of sand, gravel and crushed rock) were used in the building of this plant. The plant as it is to-day represents an actual cash investment of $2,750,000, and the daily capacity is 6,000 barrels of cement.

EQUITABLE SPECIFICATIONS AND CONTRACTS

BY HILLIS F. HACKEDORN,[1] INDIANAPOLIS, IND.

Non-member

THE American Society of Engineering Contractors, ever since its organization in 1909, has had a number of ideals to which it has clung tenaciously. One of these is the idea of equitable specifications and contracts: specifications that are written fully and completely describing the work down to the minutest detail, eliminating all guesswork and conveying to the contractor completely the ideas of the engineer; describing fully what work he expects to do, how he expects to do it, sequence of the performance and the results he expects to obtain, leaving nothing for future argument, nothing for guesswork.

In reading over many specifications and contracts, it more than frequently occurs to me that the engineer who has written them seems to take the position that the contractor is bound to be dishonest, ever ready to take advantage of the slightest point to "put one over" the engineer and owner. But all contractors are not dishonest, and it has been my pleasure during an experience of almost 20 years in the construction of reinforced concrete bridges, to meet a number of gentlemen in the contracting business with ideals and aims as high and honorable as in any other industry, occupation, business or profession; likewise have I met contractors whose knowledge of the contracting business, and incidentally of the engineering profession, has been as broad, liberal and authentic as any engineer I have ever known.

One of the greatest impositions that is ever placed on the contractor is by the engineer whose specifications fairly teem with the expression "to the satisfaction of the engineer." This very-much-abused, never-understood, and impossible-to-forecast expression is about as serious a handicap as can be hung onto a contractor who is making up an estimate of cost on any type of construction. It leaves such a wide field for guesswork, it opens up such a broad avenue of opportunity for the engineer or inspector to "get even" with the contractor for some fancied or real grievance. It is something against which a contractor has no opportunity whatever to protect himself.

This phrase impresses the contractor as an evidence of either lack of knowledge on the part of the engineer or laziness in preparation of the specifications, and in many instances the contractor views these clauses in the light of a club to be held over his head during the construction of the work. They impress him with the belief that the engineer *thinks* he wants certain things done but if the contractor learns during construction that the engineer wants something else done, the contractor must pay for the change. The engineer should be sufficiently advised and have sufficient knowledge of all conditions surrounding the work to enable him to make up a correct detailed guaranteed design and estimate. He should have the nerve to stand pat on his estimate and likewise should not expect the contractor to make good the cost of any mistake he may make in the preparation of plans and specifications; neither should the contractor be put to the expense of thoroughly checking the engineer's estimates, and all engineering and contractors' organizations should join in an effort to educate specification writers to a proper conception of what is fair and equitable to owners, engineers and contractors alike.

In Great Britain carefully prepared schedules as to quantities are submitted to the contractor. These quantities are guaranteed, and in case of error, the contractor has a ground of action against the quantity surveyor if his bill of quantities is wrong. This method enables the contractor to estimate much more closely as to the cost of the work than under customs in this country, where all estimates of quantities are *frankly* labeled as guesses, and the engineer dodges all responsibility by stating that the contractor must assume all the hazard as to errors in such estimates. Of course, the contractor under these conditions, must charge for an element of chance which should not enter into the proposition. The engineer should make his estimates carefully and thoroughly and be ready to stand behind them in case of error. I know of but one bridge engineer who guarantees his quantity estimates and as a result bidders can make much closer estimates, knowing as they do, that he will stand responsible for any errors in his quantity statements.

An unfair engineering practice frequently resorted to in the writing of specifications is to require the contractor to prepare the detailed working drawings for the job, including, for reinforced concrete, bending diagrams and special details as to connections of reinforcement, thereby making it necessary for the contractor to maintain a much more extensive engineering and drafting department than would be otherwise required if the engineer did his full duty, preparing all detail plans and working drawings so that there would be no question in the contractor's mind, when he bid on the work, exactly how the work was to be executed to the most minute detail. In addition to this, some specifications require that the contractor "having checked the plans shall be responsible for the correctness of all drawings, as to dimensions, elevations and mutual correlation of various parts," thereby making the contractor absolutely responsible for the correctness of the engineer's design and drawings, and in case of an error, the expense of correction is unfairly placed on the contractor. The contractor is given no extra allowance for preparing these drawings, but must do it at his own expense and deduct it from his estimated profits, when it should be taken from the engineer's fee.

Our position in the matter of detailed specifications is that we know of no legitimate reason why the contractor should not have full detailed information as to what will be required in the execution of a given contract *before* the contract is signed, rather than make haphazard guesses on small scale drawings and indefinite specifications frequently lacking in vital information. If detailed drawings have not been completed before the date upon which bids are requested, the date should be postponed to give the engineer an opportunity to prepare complete working drawings. It takes no longer to study the details of a structure before the contract is executed than after, and a careful preparation of detailed drawings and the writing of complete specifications, would frequently result in saving of cost to the owner because of the necessity of the contractor to add a certain percentage to cover the uncertainties of plans and specifications.

Another question in which many engineers err in judgment is in specifying a short time for completion and requiring the starting of work immediately upon the awarding of contract. A short limit reduces competition because it admits only the contractor who is fully equipped and ready to begin immediate work, and where a short time limit is provided, the engineer should include a certain compensation to cover the cost of night work necessary on the part of the contractor in order

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to complete the work within the time set. It has been our experience that where the engineer cooperates with the contractor, the quality of work is very much improved, resulting in a great benefit to the owner. Of course, if the contractor knows that the engineer is disposed to treat him fairly and not impose unnecessary hardships upon him, he will in return for this confidence, exert every effort to give the owner the benefit of his experience in producing the highest class of results. If the engineers will write their specifications with the most complete details, setting out definitely in every paragraph what is expected, how it is expected to be done, avoid all reference "to the satisfaction of the engineer," then when the contract is commenced the contractor understands the case, what he is expected to produce for the compensation promised him, and there is no argument, no quibbling and no trouble. An owner gets a high class piece of work, the contractor gets paid for doing it and the engineer reaps the credit for the design.

One of the most dangerous conditions in the great majority of specifications is the clause providing that the engineer shall be the final judge as to the interpretation of the specifications. The lawyer would call this ex parte, for the reason that the engineer is in the employ of the owner, and his judgment is bound to be biased toward that side.

One manifestly unfair condition in many specifications is that of giving the engineers the right to make minor changes in the plans, without extra compensation to the contractor, unless "in the opinion of the engineer" he is entitled to such extra compensation, the amount of any such extra compensation to be determined solely by the engineer. This condition leaves a very large opening and opportunity for the engineer to abuse his authority over a contractor whom he does not like, or seriously cripple him, when the wrong man, in the opinion of the engineer, has landed the job.

One of the ideals of the American Society of Engineering Contractors is that the specifications should provide in the event of any disagreement between the contractor and engineer, regarding the reading of the plans or the interpretation of the specifications, the quality of the work, the justice of any claim for extras, or any other controversy arising out of the contract or the specifications, that such question shall be submitted to arbitration—the engineer and owner on the one side and the contractor on the other being bound beyond appeal, to the decision of the arbitrators. In our opinion, this removes the danger of the contractor being injured by the decision of the engineer, or the owner being defrauded by any unfair work of the contractor. It would mean the elimination of controversies between engineer and contractor and place their relations on the broad peace basis of arbitration, that is bound to be a controlling spirit in future times, which we trust are not far distant.

In my mind, one of the greatest injustices which enters into nearly all specifications, is the clause requiring the contractor to "indemnify, keep and save harmless the owner and engineer from all liabilities, judgments or costs and expenses which may in any wise come against the owner or engineer on account of any infringement of any patent on the use of any design, material, machinery, device or apparatus used in the performance of the contract." In other words, the engineer goes along, prepares his design, specifies his materials and method of construction and puts the responsibility on the contractor for ascertaining whether or not there are any patents on the type of design, or material used, or on the method of construction. It seems to me that this is part of the duty of the engineer, and that in making his design he should ascertain beyond the possibility of a doubt whether or not his design infringes any of the many patents which have been granted by the Patent Office at Washington, and in case he cannot make a design without infringing a patent, he should either notify all bidders of the existence of such patent, and the fact that his design infringes, or he should obtain from the owner of the patent the right to use it for a specific price on the work. It is entirely unfair to shoulder this responsibility and liability on the contractor, in addition to the many other troubles which he has to guard against in executing the contract.

Another inequity is that of giving the engineer the right to direct the sequence of the work and issue orders as to the manner and time in which the various parts of the work shall be done, and the force required to complete it within the time specified. I believe I can state, without fear of contradiction, that no two contractors would handle the same job in the same manner and sequence. It is customary in making up estimates, to carefully plan the manner and sequence of the construction, and if the contractor is not permitted to follow his own methods, it frequently results in turning a contract, that would otherwise be profitable, into one that results in a loss to the contractor.

The experience of many contractors has demonstrated that many of the engineering profession are guessers on cost construction with no actual experience to guide them. Of course, we as contractors do not charge the engineering profession with doing this guessing on cost with any malicious intent to injure a contractor, but the result is the same. If an engineer, having a lack of actual knowledge as to the cost of the various elements making up the construction of a given piece of work, relies on a rough guess, it is bound to bring grief to the contractor, either in the way of blaming him for charging exorbitant prices for the work, or if, as is frequently the case, the contractor has had no personal experience in the cost of this element and uses the engineer's guess as a basis for bidding, he is bound to lose.

Many contractors hesitate, and some even refuse, to furnish engineers any details as to actual cost data, which in my opinion, is more injurious to contractors than to the engineers. If contractors would supply the engineering profession with actual experience data, I have no doubt the engineers would be glad to use it in making future estimates, but it is doubtful if the contractors as a class can be convinced that this method would correct frequent carelessness and loose methods in making up estimates by engineers.

Another practice followed by some engineers is the trimming and pruning of monthly estimates for payment. As a general proposition the engineer or inspector directly in charge of the job, who is frequently a young man, will make a *decided* practice of *underestimating* work actually done, refuse to include in his estimate many items which in equity, a contractor should be allowed, and then, after taking off the percentage held back as provided by the contract, a contractor gets in reality 50 or 60 per cent of his work actually done where he should get 80 or 90 per cent. Of course, this has no bearing on the engineer's ability, but it frequently embarrasses the contractor in financing big jobs.

We all know the average contractor will take on work in excess of what he really should undertake with a fair and reasonable consideration of his financial ability, which frequently makes it necessary for him to watch every corner, and make many twists and turns in a financial way to meet his payrolls and material bills. This is chargeable in most instances to ambition and an eagerness to make money, but when

this condition is evident, and on top of this, the engineer trims his estimate approximately 20 or 30 per cent below what the contractor is entitled to receive and has reasonably expected, it very often gets him between the millstones of the banks, which proverbially grind slowly but exceedingly fine.

An important point in the preparation of estimates for pay, is that engineers should make an allowance for material on the ground ready to be worked up, a sum covering forms and preliminary work, and in some instances a sum approximating the cost of new equipment that is to be bought to handle the especial job. Of course, I realize that the engineer will say that many contractors will be unreasonable in these claims, but if the engineers would show a disposition to help the contractor along these lines, I believe that 90 per cent of the contractors would be disposed to strain points in favor of the engineer and owner, and give them a higher type of construction. It would be nothing more than an appreciation of a favor extended, and along this line, we are all human and willing to show our appreciation of any such help.

The business relations between the contractor and the engineer are little understood by the public at large. We frequently hear a contractor on public work condemned for failures in bridges, roads or pavements, when he was entirely innocent, having built the work in strict accordance with specifications furnished, yet the general public makes him the goat, and the engineer, who has prepared faulty specifications, goes "Scot free." Of course, the engineer may take the high position that if the contractor does not like his specifications he need not bid on the work, but this is not only unfair to the contractor but also to the owner, because it reduces competition by eliminating intelligent and responsible contractors. Some contractors go so far as to refuse to bid on work where the specifications are not fair and completely detailed, but where a contractor has a large organization with a certain amount of overhead expense, he is, of course, anxious to make as good a showing on the capital invested as he can; hence by passing up unfair specifications, many pieces of work which he could do at a profit under fair specifications, are lost. We, as contractors, realize that one of the most difficult problems confronting an engineer is the preparation of his specifications, in making them rigid enough to control the bad contractor and at the same time work no hardship on the contractor who is honest and sincere in his work.

A prominent engineer, in a paper recently read, refers to the personality of the engineer as probably the most important factor in the relations between engineer and contractor, stating that some engineers have a notoriously bad name and do not seem to appreciate the responsibility of the honorable position they occupy. If the contract is used merely as a legal document to hold over the contractor's head as a club and unnecessary harassing and vexatious conditions insisted on, trouble will surely follow. The wise engineer knows that many contract conditions can be ignored without any harm being done, and that many facilities can be given the contractor to help expedite the work. We believe that the contractors as a body will not take unfair advantage of these concessions, but in their turn, will go out of their way, even at extra expense, to meet some special request of the engineer, playing the game of "give and take" in a reasonable way without expecting extra pay for every trifling piece of work, thus bringing about a great improvement in the relations between engineer and contractor and eliminating many of the disputes which at present are too frequent.

The National Association of Builders Exchanges, of which Mr. H. L. Lewman of Louisville, Ky., is the president, has been working for a number of years in conjunction with the American Institute of Architects, to secure standard specifications and contracts for the use of builders. Their effort has been:

To accurately define and standardize, wherever practicable, plans and specifications in order to eliminate unnecessary hazards and uncertainties in construction contracts;

To reduce the cost of improvement to the owner;

To give the contractors and surety companies a proper understanding of the obligations they assume;

To establish contracting and suretyship on a more stable and definite basis;

To provide for the settlement of differences by some equitably constituted authority;

To establish building contracts on such a basis that banks and commercial institutions may intelligently determine the amount of credit to be extended to owners and contractors, and to eliminate the present uncertain conditions of credit based on such contracts.

How well they have accomplished this work is evidenced by The Standard Documents of the American Institute of Architects in collaboration with the National Association of Builders Exchanges. These documents define the duty, scope and power of the architect, the duty of the contractors, the scope and limit of arbitration, the rights of sub-contractors and a carefully prepared, detailed article entitled: Advice to Contractors by Mr. William B. King, general counsel to the National Association of Builders Exchanges. The specifications and contract forms have been so carefully prepared and revised that it is difficult to find any point wherein there can be criticism. Their theory is to insist upon the use of the principle of arbitration on every possible question that can be settled without resort to the courts. But the greatest lesson to be derived from this joint work of these two great national organizations is the benefits and justice that are sure to accrue as a result of the joint organization, coöperation and close affiliation. The result has been to increase the membership of the National Association of Builders Exchanges more than double during the year of 1913, which number was doubled in 1914 and almost doubled so far in 1915, making this organization now one of the largest and most powerful commercial organizations in the United States, representing as it does, the broad field of building construction.

If it were possible to bring about such close relations and affiliations between the various national engineering societies, and all of the national contractors' organizations, it would be a result which would be beneficial to all engineers and contractors and almost entirely eliminate losses caused by misunderstandings of contracts and specifications. Such a uniform action could bring about an adoption of standard specifications and contracts based upon equity, intelligence and fair dealing, ever guarded by the idea of arbitration. It is my fondest hope as the executive head of the American Society of Engineering Contractors, that the day is not far distant when all of the National, State and local organizations of Engineers and Contractors may be brought into such close relationship and coöperation that equitable specifications and contracts will be the rule instead of the exception, resulting in standard forms that will not only represent fully the engineer's ideas but will be fairer to the contractor and economical to the owner. I cannot imagine a better declaration of principles and creed than that of the International Rotary Clubs, and if we can get together under some such banner, we can exemplify to the letter the motto of that magnificent organization—"He profits most who serves best."

Society Affairs

Engineering Survey

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National Defense and International Peace

What the Engineers are Doing

THIRTY thousand American engineers are making a card index survey of American industry so that it may be prepared for its vital part in defending the country, if need comes. The past eighteen months have taught us here in America what lack of industrial preparedness has meant to some of the countries now at war. These nations had the ships and they had the men; but when the hour struck, their factories were not able to furnish the colors with arms and shells and powder. Their factories were not prepared. And our factories are not prepared.

But it is not enough to draw a moral. In the United States five great Engineering Societies—Civil, Mining, Mechanical, Electrical and Chemical—have pledged their services to the Government of the United States, and are already working hand in hand with the Government to prepare industry for the national defense. They receive no pay and will accept no pay. All they seek is opportunity to serve their country, that she may have her industries mobilized for defense.

All elements of the nation's life—the manufacturers, the business men, and the workingmen—should support this patriotic and democratic work of the engineers, and assist them cheerfully when asked. *There can be no better national insurance against war.*

The Associated Advertising Clubs of the World, representing all advertising interests, have offered their free and hearty service to the President of the United States, in close co-operation with these five Engineering Societies, to the end that the country may know what the engineers are doing. The President has accepted the offer. The engineers have welcomed the co-operation.

This advertisement, published without cost to the United States, is the first in a nation-wide series to call the country to the duty of co-operating promptly and fully with the engineers.

NAVAL CONSULTING BOARD OF THE UNITED STATES

IN CO-OPERATION WITH

THE AMERICAN SOCIETY OF CIVIL ENGINEERS
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
THE AMERICAN INSTITUTE OF MINING ENGINEERS
THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
THE AMERICAN CHEMICAL SOCIETY

ENGINEERING SOCIETIES BUILDING 29 WEST 39th STREET, NEW YORK

THE SPRING MEETING

THE Spring Meeting at New Orleans, with headquarters at the Grunewald, was successful from every standpoint. The local membership of the Society, the Association of Local Members of the American Society of Civil Engineers and the Louisiana Engineering Society joined as hosts, and arrangements were perfectly worked out through their local committee, W. B. Gregory, *Chairman*, A. L. Black, *Treasurer*, and H. L. Hutson, *Secretary*.

The engineering developments of New Orleans in connection with its drainage problem, sewerage disposal and water supply and the handling of its freight for foreign shipment, are of unusual interest. The old town of New Orleans, which still reflects the characteristics of the French and Spanish who were the first settlers, is an alluring place for visitors, and dinner parties at the noted restaurants in this section were very much in order during the convention. Most of the historic buildings, sites and landmarks are to be found here and their proximity to headquarters made possible frequent between-time trips to this almost foreign land.

The papers presented were all of a high order, there was a large amount of discussion, and the keynote session of the meeting, on the subject of Industrial Preparedness, aroused a great deal of interest and called forth contributions from engineers from every section of the country.

A MESSAGE FROM PRESIDENT WILSON

My dear Mr. Jacobus:

It is with great pleasure that I acknowledge your letter of April fourth as it gives me the opportunity of expressing my appreciation of the high sense of loyalty and patriotism displayed by the members of The American Society of Mechanical Engineers in their prompt and earnest volunteer of service to the Government of this Republic. It is the kind of response that was expected from the members of your organization and is expressive of the real spirit of Americanism which is ever ready to serve the interests of our common country.

In the hope that your meeting will result in your highest anticipations, I am

Sincerely yours,

WOODROW WILSON

APRIL 7, 1916.

The attendance was good considering the great distance from the center of gravity of the Society's membership, there being a total registration of 485, of which 114 were members, 92 of whom were from out of the city. Special cars were run from New York and Chicago, through Chattanooga and stopping for a day at Birmingham, where the visitors were entertained by the newly-formed local section of the Society in that city, of which R. E. Brakeman is chairman and Paul Wright, secretary. A small group also went to New Orleans by boat from New York.

THE STOP AT BIRMINGHAM

On Monday morning, April 10, the party going by rail left the special cars for the day at Birmingham. Representatives of the Birmingham Section were on hand at Chattanooga to acquaint the visitors with the day's arrangements.

After breakfast at the Tutwiler, the party boarded a special train which was at their disposal for the day and was taken to the Thomas furnaces of the Republic Iron and Steel Company, and to several of the plants of the Tennessee Coal, Iron and Railroad Company, inspecting during the forenoon the blast furnaces at Ensley, the open hearth furnaces, the rail mill and the turbo generator station for the rail mill. The train then proceeded to Bayview where a much anticipated barbecue dinner was served on the shores of an artificial lake used for water supply for a part of the company's plants. To many this dinner was a novelty and to all it was a treat.

After dinner the party spent a few minutes at the Edgewater coal mine in the vicinity, and inspected the Fairfield by-product coke plant which produces ammonium sulphate in large quantities, and several lighter distillates of coal tar.

The last inspection was at the Fairfield plant of the American Steel and Wire Company, affiliated with the Tennessee Company. There is a large production, not only of wire, but of wire nails and wire mesh and barbed wire fencing.

Of particular interest is the welfare work undertaken by the Tennessee Company. There are 18,000 employees, almost exactly half of whom are white and half black. A considerable percentage live in company houses in separate groups for the white and the black, laid out after an exhaustive study of the best to be found among industrial communities in this and other countries. As a preventive measure, strict supervision is maintained of the sanitary condition of the surroundings and the health conditions of the people. The water supplies are analyzed once in two weeks. There is frequent inspection of the sources of milk supply, daily disposal of all waste, street cleaning, etc. Welfare workers give instruction in hygiene, in the care of yards and surroundings and in home duties. There are kindergartens for children below school age, courses in domestic science, and medical and hospital service, regardless of the extent of treatment needed, for a small sum paid monthly by each family. The company coöperates with the county in the conduct of public schools. The attractive appearance of Fairfield, the model town, the commissary department of which the visitors were privileged to inspect, and the evidence everywhere of cleanliness and orderliness throughout the various plants of the company, called forth favorable comment.

In the evening, dinner was served at the Hotel Tutwiler, after which there were several addresses. R. E. Brakeman, chairman of the Birmingham section, was toastmaster, and the visitors were welcomed to the city by Commissioner John R. Hornady, who also represented the Chamber of Commerce. Frank H. Crockard, vice president and general manager of the Tennessee Coal, Iron and Railroad Company, who is also the Society's choice in Alabama as its director for the industrial survey of the state, told something of the resources, operation and products of his company in relation to the plants which had been visited during the day.

Dr. W. F. M. Goss, Past-President Am.Soc.M.E., said a few words in response, referring to the visit of the Society

to old Birmingham in England, six years ago, and the educational institutions there. In the new Birmingham he found comparable conditions through the splendid work along educational lines among its employees by the Tennessee Coal, Iron and Railroad Company.

ARRIVAL AT NEW ORLEANS

Members of the New Orleans local committee joined the party en route Tuesday morning and gave an early greeting to those on the official train. The arrival was on schedule time during the forenoon and during the afternoon there were personally-conducted trips to the French quarter. In the evening all gathered in the ballroom of the hotel for an informal reception and dance.

OPENING SESSION

The first session on Wednesday morning, April 12, was opened by Chairman W. B. Gregory of the local committee of arrangements, whose cordial welcome made those present doubly glad that they could be there to enjoy the hospitality in store for them. Professor Gregory referred to two early and distinguished members of the Society who were claimed by New Orleans. Lewis Johnson, a charter member, remembered with affection and esteem, lived his life and died in New Orleans. For many years he was president of the Sewerage and Water Board of the city, and chairman of the Executive Committee. The work of the Sewerage and Water Board stands as a monument to his memory. The city has been transformed as regards sanitation and drainage, and has been given an abundant water supply.

The other name, high on the honor roll of The American Society of Mechanical Engineers, is that of Maunsel White, a native of Plaquemine Parish, below New Orleans. He will best be remembered for his part in the extended investigations which led to the discovery of the Taylor-White process of treating steel, and the development of high-speed steel, revolutionizing the machine shop work of the world and doubling and trebling the output of machine tools. He was a man of wide interest, who loved literature and art, a poet and mathematician. Mr. White died in New Orleans in 1912.

Following Professor Gregory, A. M. Shaw, Past President of the Louisiana Engineering Society, welcomed the visiting engineers as a representative of the Louisiana Engineering Society and of the local association of members of The American Society of Civil Engineers.

The Chairman then introduced Hon. Martin Behrman, Mayor of the city of New Orleans, who recounted briefly the long struggle of the city to solve its problems of sanitation, water supply and shipping facilities. New Orleans is an old town, full of romance and history. A great street, Canal Street, divides the old from the new. Below Canal Street are scenes that remind one of France and Spain, and above Canal Street is the bustling, up-to-date city rapidly forging to the front. He had one request. Reference had already been made to the modern water system of the city, and when strangers come to New Orleans it is insisted that they drink at least one glass of water, for there is an old adage of the French which says, "Lorsqu'on a bu de l'eau du Mississippi, on y revient toujours."

President Jacobus responded and afterwards took the chair for the session which followed on Organizing for Industrial Preparedness. It had been his privilege to arrive early in New Orleans and to attend a meeting of the Louisiana Engineering Society. Prof. C. W. Williamson presented a paper on the Industrial Resources of Louisiana which had a direct bearing on the subject of the morning's discussion. There was also a Spring Meeting paper by William Von Phul on the facilities of the Port of New Orleans. These two papers, and the remarks by the speakers of the morning, indicate the importance of New Orleans and of Louisiana as an industrial and an engineering center. Tulane University of New Orleans and the State University at Baton Rouge both contribute to this end. The engineers of New Orleans are to be congratulated on the commercial promises of the city and the features which are bound to make the locality a center of engineering; a movement in which all will wish to coöperate, since engineers in fact are all brothers and wish to pull together for the best success of all concerned.

DISCUSSION ON INDUSTRIAL PREPAREDNESS

In the absence of the author, the paper on Organizing for Industrial Preparedness by Spencer Miller, member of the Council and Representative of the Society on the U. S. Naval Consulting Board, was presented by Charles Whiting Baker. This paper has been sent in pamphlet form to the entire membership and was briefly abstracted in the last number of The Journal.

Calvin W. Rice, Secretary, read a telegram from Howard E. Coffin, Mem.Am.Soc.M.E., which called attention to the opportunity as well as the obligation resting with the members of the Society in the matter of industrial preparedness, saying that a successful performance of the great task of preparing the industrial inventory to which our technical societies have been pledged by their governing bodies cannot but bring the American engineer enhanced reputation and closer future relations with the national government. Mr. Coffin is chairman of the Committee on Production, Organization, Manufacture and Standardization of the Naval Consulting Board, through whose efforts the industrial inventory of the country is being developed.

The discussion on the paper continued throughout the morning; and in the evening, after the address by Commissioner Thompson, more time was given to the consideration of the subject and the audience had the privilege of listening to two brief discussions by representatives of the army and navy who are stationed at New Orleans. Written discussions were received from all parts of the country showing the widespread interest in industrial preparedness and containing many constructive suggestions. A full report of the session will be published in an early issue of The Journal.

At the morning session a resolution was offered and passed, proposed by L. P. Alford, requesting the Council to consider the advisability of appointing a standardizing committee for machine tools, realizing the necessity of standardization in our industrial preparation for war.

The Society was honored by receiving a communication from President Wilson, too late, however, to be read at the Wednesday morning session, congratulating the engineers on the movement which they were undertaking and heartily commending it. This letter appears on the insert on the first page of the report of the Spring Meeting in this issue.

A letter was also received from Secretary Daniels of the U. S. Navy as follows:

Accept my thanks and appreciation for your letter of April fifth and the very interesting paper of Mr. Miller which you enclosed therewith. Permit me again to express my appreciation of the service your Society is rendering to the country

Yours truly,

JOSEPHUS DANIELS.

WEDNESDAY AFTERNOON AND EVENING

It was the intention of the Committee on Meetings that, following the session on Wednesday morning, the local committee at New Orleans should be given the balance of the day and the whole of Thursday to carry out such plans as they had arranged for. Accordingly, the session on Thursday morning consisted of papers on local subjects by local engineers, and Wednesday and Thursday afternoons and evenings were devoted to various entertainment features.

On Wednesday afternoon there was a trip on the steamer Sidney to inspect the harbor of the Port of New Orleans, formed by the Mississippi River. There are many miles of water front controlled by the Board of Port Commissioners as representatives of the State of Louisiana, and the docks and warehouses, totaling nearly 20 acres in area, are uniformly of most modern construction with mechanical handling devices, as, for example, for the unloading of bananas, one of the chief imports, for which specially designed conveyors are used. The exports and imports through the port of New Orleans are valued annually at over $300,000,000.

During the trip a landing was made at the recently constructed public cotton warehouses erected at the expense of $3,000,000 for the safe storage and shipment of cotton. This not only provides the best possible facilities for handling at low cost, but the large storage capacity enables the cotton crop to be handled at the most advantageous time in relation to the market conditions.

Many interesting facts about the harbor and the cotton warehouse were brought out in the lecture by Commissioner W. B. Thompson, given in the evening, on The Debt of New Orleans to the Engineer, an abstract of which follows this report. Mr. Thompson's address was carefully prepared, pleasingly delivered, and gave the visitors a most acceptable resumé of the striking engineering developments of New Orleans which have meant so much in the city's growth and for which the city is indebted to the engineer as its master worker.

THE DAY THURSDAY

At the session on Thursday morning, devoted, as stated, to subjects of local interest, the following papers were presented which drew out considerable discussion: Capacity and Economy of Multiple Evaporators, E. W. Kerr; The Evolution of Low-Lift Pumping Plants in the Gulf Coast Country, William B. Gregory; Mechanical Equipment Use in the Port of New Orleans, William von Phul. The paper by Professor Gregory is given in this number of The Journal and an account of the other papers and a discussion upon all of them will appear in later issues.

Several clubs of New Orleans, including the New Orleans Country Club and the Chess, Checkers and Whist Club, extended their club privileges to the members and on Thursday afternoon as many as desired to go were taken in automobiles to the Country Club, one of the beauty spots of the city, which, unlike most such outdoor places, is located near the center of the city and conveniently accessible from almost any point. From here the party went to the Newcomb School of Art, a department of Newcomb College, the woman's college of Tulane University, where many beautiful art objects are made by the students under the personal direction of their instructors. The Newcomb pottery, which is widely known as ranking among the most attractive products of the potter's wheel, is made and decorated here with designs characteristic of the Southern flora, rich and beautiful in its subdued tones. The visitors were graciously received at the school by ladies of New Orleans and the students of the college. Tea and refreshments, including New Orleans candies, were served, and the college glee club afforded entertainment.

On Thursday evening was the culminating feature in the reception and dance held in the ballroom of the Grunewald, which was largely attended and greatly enjoyed.

FRIDAY, THE FINAL DAY

On Friday morning were simultaneous sessions at which the following list of papers was presented: Establishing a Standard of Measurement for Natural Gas in Large Quantities, Francis P. Fisher; Deviation of Natural Gas from Boyle's Law, Robert F. Earhart and Samuel S. Wyer; Some Experiments on Water-Flow Through Pipe Orifices, Horace Judd; Dynamic Balance, N. W. Akimoff; The Measurement of Viscosity and a New Form of Viscosimeter, H. C. Hayes and G. W. Lewis; On the Transmission of Heat in Boilers, E. R. Hedrick and E. A. Fessenden.

Dr. Jacobus presided at one session and Professor Gregory at the other. At the former D. R. Yarnall of Philadelphia offered a resolution to which he had previously referred at the Wednesday evening session, stating that as engineers we should seek to find and remove the causes for war with even greater effort than we devote to national defense, and by the same methods of scientific research as followed in our other professional work; and providing that the members present should request the Council to appoint a committee of five to consider and report to it as to whether there is any way by which the profession can exert its influence toward the prevention of war.

This resolution was warmly seconded by H. L. Hutson, Charles Whiting Baker and others, Mr. Baker saying that it is our duty as American citizens to take our part and assume our responsibility as leaders in industry in molding a right public opinion in matters of this sort, and that it is the engineer's responsibility to find the sources of trouble and to remove them rather than merely to remedy troubles when they appear.

One view expressed was that the gathering was a small one to pass upon so important a resolution for the Society at large. Upon vote the motion was finally laid on the table. Later a resolution was unanimously carried to extend a vote of thanks to all who had participated in the substantial evidence of friendship and good will shown during the convention and expressing the sense of gratitude which every visitor personally felt.

On Friday afternoon a party was taken to the New Orleans Lake Shore Land Company's project to inspect the reclamation work in process there. This trip was of interest for other as well as its engineering features, because the tract is devoted to the growing of oranges. The large developments of this kind which have come into being during the past few years in the vicinity of New Orleans are very fully outlined by Professor Gregory in the present number of The Journal.

SATURDAY

Probably a third of the visitors remained for the day Saturday to continue their trips about New Orleans and on this day as well as previously, many took occasion to inspect some of the most interesting municipal plants, including the water filtration and pumping plant, and certain of the drainage pumping stations.

THE DEBT OF NEW ORLEANS TO THE ENGINEER

Address by W. B. Thompson, Commissioner of Public Utilities of the City of New Orleans

On Wednesday evening of the meeting, an address was given by W. B. Thompson, Commissioner of Public Utilities of the City of New Orleans, in which was summarized the salient features of the great engineering enterprises which have been carried through by the engineer for the benefit of the municipality. Mr. Thompson said in part:

The City of New Orleans, as age is reckoned on this side of the sphere, is an ancient city. While its growth has not been rapid, nevertheless, when consideration is given to the difficulties which its people have encountered, we have reason to be proud of its record. When, in 1718, Bienville established his civic corporation on the banks of the Mississippi River between destroying flood and miasmatic swamp, the destiny of New Orleans as the daughter of effort, struggle and self-defence was irrevocably fixed. What its people have has been *won*; and the fortitude and spirit of self-reliance which are the products of victory over hostile forces are more valuable than mere prosperity as the result of a fortunate inheritance.

THE FIGHT FOR LIFE AND PROPERTY

Situated in a basin between the river and the lake, with the highest point behind the river banks lower than the high water level of the river, and with the greater portion of its land lower than the high tides of the lake, it is perceived that the first misfortune which threatened the young community was the destruction of life and property by flood and overflow. The engineering genius of that crude period took hold of the situation and built levees, first for protection against the river floods and later against inundation from the high tidal waters of the lake. These primitive improvements constituted the beginning of the levee system which, though not always an impregnable defense, has at least given sufficient protection to make a great city possible, and finally under progressive improvement, has made New Orleans flood proof.

THE FIGHT FOR HEALTH

Until the latter part of the century just closed a few years ago, the City of New Orleans seemed permanently held within the bondage of insanitation. Because of its topographical location the soil was super-saturated and soft. There was no drainage system worthy of the name. Mosquitoes were plentiful. There were no sewers. For a water supply the city depended mainly upon overhead cisterns storing water caught from the roofs of the houses. Sometimes the supply was insufficient and in consequence inconvenience and suffering resulted. At all times the water so caught was unclean and oftentimes impure, and unsafe. The so-called public supply provided by a private company was water pumped directly from the Mississippi River, which in its natural state was too muddy to be of much practical use, and which as a filtered product was too expensive to encourage any general consumption. It is not surprising that as results of these conditions the disease and mortality rate was high, growth in population slow and business enterprise unprogressive.

But there were dreamers among the people and their dreams have all come true. A few dauntless men and women in the late nineties led a movement under the force of which the people of the city were aroused to vote the measures required to finance a complete and comprehensive system of sewerage, drainage and water supply.

SEWERAGE, DRAINAGE AND WATER SYSTEM

The chasm separating project from realization is ever broad and deep and notwithstanding the fact that the tax to provide the necessary means had been voted by the people, consummation was still afar. Many asked, how was it possible to overcome the hitherto unconquerable natural difficulties? How was it possible to trench and effectively drain the sodden soil, to sewer the city safely and to supply the required amount of pure water at a cost within the reach of all? Every citizen realized that the undertaking was gigantic, many believed it to be impossible. It is needless to say that the men who accomplished the herculean task were engineers.

It is no part of my purpose to try to tell how the thing was done and I am destitute of any scientific knowledge as to how the several functions of the completed system are performed. I do know, however, that the soil is no longer soft with super-saturation but is firm and dry; that waste matter heretofore disposed of in a manner offensive and injurious is now, through our sewerage mains, carried secretly into innocuous oblivion; that a limited supply of muddy river water and impure cistern water has been replaced by an unlimited volume of clear, pure liquid as good and as cheap as any city supply in the world; and that since our sewerage, drainage and water facilities have been in operation the mortality rate and the disease ratio of the community has shown a phenomenal decrease and that our health statistics compare favorably with those of our sister cities.

Although good health conditions constitute the foundation upon which any and all civic progress must of necessity be based, still the solution of the physical problems alone by no means answers all of the demands of the city's well-being and well-doing. New Orleans is the seaport of the Mississippi valley, the gateway through which this, the most prolific section of the United States, should and to a large extent does send its surplus of production into the great world market. But even as the old city was restricted by the bonds of insanitation, so was the seaport of the older days hampered in its development by intrinsic defects of equal relative importance.

PUBLIC DOCKS

The docks and shipping facilities of the port are of necessity the vital factors of its existence. They constitute, in figurative speech, the channel through which the stream of foreign commerce flows. If this channel be narrow or is usable only at a high toll of expense, then the volume of business passing through will be restricted to the necessary movement and the increase of such volume will be discouraged.

Under the former regime the dock facilities of the Port of New Orleans were operated by private persons or corporations under lease from the State. This policy of administration of an essentially public utility is vicious from the core. The results that followed from the instance in question were the results which always follow the surrender of such a distinctly public function to the grasp of private monopoly and private greed. The wharves supplied by this private administration were merely wooden floors of primitive construction, open and exposed to the elements, limited in area, destitute of equipment, expressive to the users and wholly inadequate both in point of capacity and service to properly care for the business from necessity forced thereover or to encourage a new and broader commerce.

Some seventeen years ago the State, led by men of vision who appreciated the great advantages to be derived from the public ownership and operation of the port facilities, redeemed the river front from its bondage to private interests and inaugurated the system of public administration, of which our splendid dock equipment of today, capable of caring for the second largest export and import movement in the United States, is the result.

Under the administration of the State through its instrument, the Board of Commissioners of the Port, the wretched equipment of the old order has been replaced at the cost of approximately four million dollars, by more than five miles of commodious wharves of the most substantial construction, protected for the much greater part by steel sheds of the best approved design. Instead of excessive charges for poor service, commerce now pays for a high and improving and expanding order of service the minimum impost consistent with proper operation and the protection of outstanding bonded obligations.

PUBLIC BELT RAILROAD

But the port problem is not settled by the construction of a dock system, no matter how commodious and complete these particular facilities may be. It is necessary to supply the means whereby export goods in quantity may be assembled on the docks for shipment, and whereby imports may be from the docks distributed through the several avenues of transportation to local or inland destination. These means are supplied by the terminal switching facilities of the port.

Under the old order, the important detail of terminal switching was operated by the several private railroad lines which had secured track privileges along the commercial river front. The track grants under which the railroads operated were each limited to a certain locality, hence each grantee could operate only on its own unit. This arrangement subjected the general commerce movement to the necessity of interchange between the switching railroads, and the number of interchanges would run from one to five according to the origin and destination of the freight handled in the switch movement. Moreover each railroad operating on its own unit naturally levied its own separate switching charge, and naturally was not particularly interested in the expeditious movement of freight originating on or destined to other lines. The inevitable result of such a situation was that excessive burdens both in respect to cost and delay were imposed upon the intermediate freight traffic of the port, and in consequence shippers were, to a great extent, forced into the wholly uneconomic alternative of draying. Under these transportation conditions not only was the movement of commerce seriously impeded, but any future considerable growth was rendered impossible.

Again dreamers in the community, some seventeen years ago, began a movement looking towards the unification of switching facilities under municipal ownership, control and operation and about eight years ago this movement reached the stage of concrete reality through the inauguration of a Public Belt Railroad system by the City, to be administered through the instrumentality of a board, called the Public Belt Railroad Commission of the City of New Orleans. Up to the present time the Belt Railroad system has cost approximately one million dollars. It has some fifty-three miles of track, including main lines and switches, already constructed and additional mileage is about to be constructed. It serves the public wharves and the public warehouses, supplies switch track facilities to a large and constantly increasing number of mercantile and industrial plants, connects and interchanges with all railroad lines, and finally, effects upwards of 250,000 car movements per year at the flat charge of two dollars per car to or from any point on the system, which charges cover the double movement of the loaded and empty car.

PUBLIC WAREHOUSES

In the movement of export and import commerce a portion of the freight must be assembled prior to ocean shipment in the one case, or inland distribution in the other. The wharves are intended for transit goods and should not and cannot be utilized for the storage of commodities detained for any considerable length of time pending shipment or re-shipment. In the conduct of the export and import business, as well as in the operation of a market of deposit and distribution, a material proportion of transit freight and market deposits require this sort of storage accommodation. It is obvious, therefore, that warehousing facilities constitute an essential adjunct to a complete port equipment.

Under the old order there was no such adjunct. Such warehousing facilities as were available were supplied at high cost by private enterprises in plants located without reference to the docks, and at inconvenient distances therefrom, thereby entailing excessive expense on the goods so housed, or else undue crowding and congestion on the wharves, or both.

In line with their forward movement, the people of Louisiana in 1910, by an amendment to the Constitution of the State, supplied the Board of Commissioners of the Port with the necessary authority to construct a system of warehouses to be operated in conjunction with the dock facilities. Under this authority, at a cost of approximately three million dollars, the board has recently built a monster cotton warehouse, has already begun the construction of a grain elevator and warehouse, which will require approximately one and a quarter million dollars to complete.

THE COTTON WAREHOUSE

The improved facilities which the cotton warehouse supplies for the more profitable marketing of the cotton crop, invests it with an economic significance which reaches out beyond the limits of the port of New Orleans, and through its bearing upon the cotton problem touches the vital interests of the entire South.

The value of the cotton crop amounts annually to approximately one billion dollars, but under the faulty and uneconomic marketing methods which have prevailed, this great product has not yielded a full return to the producer. The cotton crop, which requires nearly twelve months in the making and harvesting, and fully twelve months in the spinning, has heretofore passed from first hands within three or four months. The great bulk of the crop has been precipitated upon the market during the last three months of the calendar year. This uneven distribution is all in favor of the buyer, hence it means low prices to the seller.

The cotton crop to a very considerable extent is made on credit. When harvested, the farmer must pay his debts, for which he must either borrow money on his cotton or sell it. In order to borrow he must be able to carry his cotton in a safe, dependable warehouse and receive therefor, for negotiation, a good warehouse receipt. If these conditions could not be fulfilled he could not borrow on living terms, if at all. Unfortunately the general warehousing conditions in the South have fallen far short of fulfilling these prerequisites.

The people of Louisiana have taken the first great step toward reforming these uneconomic conditions. The mammoth State-owned plant, equipped with most modern and efficient devices of safety and operation supplies the necessary facilities; administered under the economies of public ownership, the absolute minimum of handling and carrying charges is assured; and guaranteed by the good faith and credit of a sovereign state, the warehouse receipts covering the commodities stored therein are current in all the money markets in the world, and what is most important current at low interest rates. The public cotton warehouse is therefore not only a monumental exhibit of modern engineering skill, and not only an imposing unit of our port equipment, but it is the exponent of an economic principle which in logical operation is destined to revolutionize the cotton trade, emancipate the cotton producer and establish American markets for the world-wide distribution of an American product.

And so the city's fight for economic progress was won.

PREPAREDNESS

The port which offers the maximum of facility at the minimum toll places the merchants and manufacturers within and in the territory behind it in the most advantageous competitive position with regard both to the sale of their output abroad and traffic in foreign commodities at home. The extent to which the American exporter can compete with or undersell his rivals in the foreign markets depends, to a large extent, upon the cost of placing his commodities in such markets; and the price at which domestic consumption shall secure its foreign supplies is materially affected by the cost of importation and distribution. Hence, the extent, the completeness and the availability of port terminal and transportation facilities, and the cost at which these are supplied, are items of importance not only to the port city itself but to the entire territory tributary thereto. These considerations, important at all times, are vital at this time, in view of the impending trade revolution which will involve the United States and the world. The doctrine of commercial preparedness cannot be too vigorously advocated. There is hardly a more important element in trade preparation than the development of the port facilities mentioned. In point of present ability to handle the great volume of export and import traffic now moving, the New Orleans equipment equals that of any port in the United States; and in point of capacity for indefinite expansion and for encouragement of a broader commerce, the port organization of New Orleans is distinctly superior to any.

THE DEBT

But let it not be imagined that the revolution in sanitary and economic conditions which has worked the transition of the old city of romantic history into the new city of virile though no less romantic promise, was accomplished without travail and suffering, or that the improvements of which we are justly proud and for which we are duly grateful have sprung from the ground in a night like Jonah's gourd, or have flowered from the glib facility of the orator's period or the demagogue's promise. It has required effort, long continued and stern, and work, even to prepare the ground for these developments. But after the ground has been prepared and the plans formulated, and even after the means for consumation had been secured, the *Fact* was yet afar, and our fine projects still remained nothing but dreams and nebulous hopes until the *Engineer* was called and this great materializer took hold and wrought the miracle of translating the ideal into the real.

NOTES

Those who arrived in New Orleans by boat had the pleasure of attending a meeting of the Louisiana Engineering Society on Monday evening, April 10, when a paper by Prof. C. W. Williamson of Tulane University was presented on the possibilities in Louisiana for additional chemical industries, and through the courtesy of that society copies of the paper were placed at the headquarters for any who desired them.

Splendid service is being rendered in the development of the resources of Louisiana and the south by the graduates of the technical courses of Tulane University at New Orleans and of the State University at Baton Rouge. Many of the students at Tulane attended the sessions of the Spring Meeting and the members of the Student Section of the State University came to New Orleans to hold a dinner during the convention, which it was the pleasure of the President and Secretary to attend.

The five members of the Nominating Committee, selected by the Local Sections of the country and appointed by the President on their recommendation, were on hand from the five cities of Boston, Philadelphia, Atlanta, Chicago and San Francisco. Several meetings were held, but no intimation has been given of the outcome of their deliberations. The procedure followed by Dr. Jacobus this year in appointing this committee received words of approval on every hand.

The efficient local committee consisted of W. B. Gregory, *Chairman;* A. L. Black, *Treasurer,* and H. L. Hutson, *Secretary,* who acted in coöperation with several sub-committees, of which the following were chairmen: George H. Davis, Finance; H. F. Rugan, Hotels; A. M. Lockett, Entertainment; R. T. Burwell, Reception; E. L. Jahncke, Printing and Publicity. These chairmen and J. F. Coleman, President, New Orleans Association of Members A.S.C.E., Samuel Young, President, Louisiana Engineering Society, and L. C. Datz, constituted the Executive Committee.

COUNCIL NOTES

At the meeting of the Council on April 11, 1916, held at the headquarters of the Spring Meeting, Hotel Grunewald, New Orleans, Louisiana, the following were present: D. S. Jacobus, *President,* W. F. M. Goss, James E. Sague, Members of the Council; Oberlin Smith and S. T. Wellman, Past Presidents, and Calvin W. Rice, *Secretary.*

The President reported the appointments of George I. Alden, G. C. Anthony, H. S. Baldwin, A. G. Duncan, C. H. Fish, W. A. Hall, Franklin W. Hobbs, W. R. Park, George F. Swain, J. A. Tilden, A. C. Walworth, A. K. Warren, H. S. Baldwin, G. H. Barrus, John A. Stevens, Richard H. Rice, C. T. Plunkett, E. F. Greene, E. W. Thomas and C. T. Main as Honorary Vice-Presidents to represent the Society at the funeral of C. J. H. Woodbury, an organization member of the Society.

H. C. Gardner was appointed to represent the Society at a conference in Chicago, April 14, called by Dr. F. H. Newell on "Engineering Coöperation."

The President reported invitations to the Society to participate in the exercises to be held on the 150th Anniversary of the founding of Rutgers College, and at the opening of the new buildings of the Massachusetts Institute of Technology. The Council requested the President to be present and represent the Society, but if not possible the President was authorized to appoint a representative.

Subject to the approval of the Committee on Sections, the following committee was appointed in charge of the Atlanta Section: E. F. Scott, *Chairman,* P. A. Dallis, *Secretary,* Oscar Elsas, L. W. Robert and F. H. Neely.

F. W. Dean, *Chairman,* J. S. Coon and A. M. Mattice were appointed a Committee on Resolutions on the death of Honorary Member and Past-President E. D. Leavitt.

A communication was read from the Boiler Code Committee with respect to the standardization of open feed water heaters, and it was voted that the President nominate a committee to undertake this work.

CALVIN W. RICE, *Secretary.*

COÖPERATIVE SPIRIT AT NEW HAVEN

It is believed that never before has the spirit of coöperation so permeated a Local Section meeting as it did the Spring meeting of the New Haven Section held on April 5.

In the first place, no less than seven other local organizations coöperated with the Section in carrying out the program of the meeting. These were the Engineers' Club of the Sheffield Scientific School, Yale University; the Yale Mechanical Engineers Club, Student Branch, Am.Soc.M.E.; the Yale Branch, A.I.E.E.; the Mining Society of the Sheffield Scientific School; the Connecticut Society of Civil Engineers and Surveyors; the Winchester Engineering Club; and the Yale Dining Club.

In the second place, particularly at the afternoon session, the audience included many manufacturers and representatives of local industries who "came to get information the engineers had to give them."

Other evidences of the coöperative spirit manifested themselves throughout the meeting, resulting in the most successful get-together meeting yet held by this progressive Section.

Following the precedent of this Section, two sessions were held, one in the afternoon and the other in the evening, and a dinner was served between the sessions. This Section holds two such meetings each season. The meetings were practically continuous from 3 p. m., to 10:30 p. m., with the interest maintained all through, thanks to the efforts of the New Haven Committee and of the officers of the coöperating organizations.

Henry B. Sargent, Chairman of the New Haven Section, Am.Soc.M.E., opened the afternoon session in the Mason Laboratory of Sheffield Scientific School, with an attendance of about 150. After the usual announcements, Prof. L. P. Breckenridge took the chair, and introduced H. I. Harriman, civil engineer, of Boston, who presented a paper on The Water Powers of New England. The speaker called attention to the fact that on account of the general poorness of the New England soil for agricultural purposes, the people had early been obliged to turn their attention to manufacturing, with the result that they had early made demands for power. He reviewed the history of the efforts to supply this power by utilizing the available water; and by means of lantern slides he gave recent examples of impounding reservoirs and hydroelectric plants in New England. He then gave a detailed description of the construction of the Moosehead Lake Dam and the Somerset Dam, and the hydroelectric plants on the Deerfield River, concluding with illustrations of recent equipment for long distance transmission lines.

This paper was followed by a general discussion on The Power Requirements of Connecticut Industries, opened by R. J. S. Pigott, Mem.Am.Soc.M.E., who gave a large amount of valuable data on the cost of steam power in a modern industrial establishment, and methods of reducing that cost. One of the most interesting phases of Mr. Pigott's discussion was the question of bleeder turbines and their economy in plants using a large amount of low pressure steam for heating and for processes. Another was the question of individual motor drive vs. group motor drive, which latter he strongly advocated; he said that many plants were "overmotored," with the result that most of the motors were running on only a fraction of their load for the greater part of the time, insufficient attention being paid to diversity factor in loading.

Others taking part in this discussion were John W. Lieb, Mem.Am.Soc.M.E., who took up the question of water power vs. steam power, and said that none of our large centers of population could afford to depend solely on water-generated power, and that the best we could hope for in large cities was the utilization of power from all kinds of sources; S. Ferguson, who said that the primary need in all industries was reliable power, and that to increase reliability many water powers should be, and were being, "tied-in" with steam powers; Prof. C. F. Scott, who said that in the case of any manufactured article, since the cost of power to produce it was not over 1 per cent of the cost of the article, doubling the cost of power to secure reliability would be justified; C. R. Harte, who advocated greater study of such problems as re-forestation, etc., before deciding on sites of impounding reservoirs for water powers; Prof. Breckenridge, and others.

Calvin W. Rice, Secretary Am.Soc.M.E., spoke for a few moments and commended the Section upon the splendid results of its coöperative work as evidenced by such a successful meeting. He also gave recent illustrations of our Society's coöperation with the other national engineering societies and with the Government in engineering matters affecting the nation-at-large.

Winfield S. Huson, Mem.Am.Soc.M.E., expressed his admiration of the good fellowship in evidence at the meeting, quoting the words of Grosman:

"To-day a man who is out of touch with fellow-men is a useless man. His beatitude and exaltation do not in the slightest enhance his value. For men ask of one another that each help in the work and business of life, and contribute his ability and his manhood."

Following the afternoon session an excellent dinner was served in the inspiring Yale Dining Club Hall.

The evening session, held in North Sheffield Hall, was devoted to a paper on The Progress of Economic Power Generation and Distribution, by Samuel Insull, President of the Commonwealth Edison Co., Chicago. The meeting was opened by President Arthur T. Hadley, of Yale University, who introduced the speaker. There were about 300 present.

Mr. Insull's paper, which was profusely illustrated with lantern slides, reviewed the history of the business of electric power generation and distribution, from its inception in the early 80's to the present time, with special reference to the speaker's own connection with the business in the City of Chicago.

Mr. Insull considered the limitations of the early business, when small areas only were served and when there was no diversity. He described the effect of the introduction of the a.c. system and, later, of the steam turbine, to which he paid tribute by saying that the introduction of this prime mover was the one thing above all others which had made possible the massing of production of electric power for all kinds of purposes.

By means of slides, he contrasted the early apparatus used in the business with that now used, and traced the evolution of this apparatus through its radical stages of development.

He gave his opinion that the limit of economical size of unit was reached in the large units now being employed, and that it was unwise to exceed these maximum sizes.

He concluded with a discussion of some of the figures of modern electric production, and the effect on them of increasing the diversity of utilization by "massed production," generating power for all kinds of purposes.

CONFERENCE ON ENGINEERING COÖPERATION

The second conference of the Committee on Engineering Coöperation, to which our Society was invited to send a delegate, was held in Chicago, April 13 and 14. The Committee is self-constituted, and Dr. Frederick H. Newell, Mem.Am.Soc. M.E., is chairman and Clarence E. Drayer, is secretary; its aim is the formulation of a plan of increased coöperation between engineers with a view to securing greater efficiency in the larger matters of concern to the individual engineer, the profession and the public. Over thirty technical and engineering societies, engineering clubs, and like organizations were represented at the conference. H. C. Gardner, Mem.Am. Soc.M.E., attended as the delegate of our Society.

The conference was opened by the chairman, greetings were extended by B. E. Grant, President of the Western Society of Engineers, and an address of welcome delivered by B. F. Affleck, President of the Chicago Engineers Club.

During the conference there was a good deal of discussion upon the scope of the plan of attaining the objects in mind; as to whether a separate organization should be formed or how best the activities of the existing societies could be correlated. The representative of our Society argued for the development of the plan through existing organizations. At the close of the conference resolutions were passed establishing a subcommittee, with Dr. Newell as chairman, to prepare a plan for consideration at a third conference on engineering coöperation, to be called by the subcommittee at such time and place as may seem to be desirable, and expressing appreciation for the courtesies extended to the delegates.

SCIENTIFIC MANAGEMENT CONFERENCE

An elaborate conference on Scientific Management has been planned by the Frederick W. Taylor Coöperators, to be held at the University of Michigan, Ann Arbor, Mich., from May 11 to 13, 1916. A feature of the conference will be seven round table discussions on scientific methods of management applied to various types of industry.

The address of welcome will be delivered by President Harry B. Hutchins, of the University of Michigan, and Harlow S. Person, President of the Taylor Society, will respond.

Papers will be presented on Scientific Management, Its Nature and Significance, by Henry P. Kendall, Mem.Am.Soc. M.E.; Scientific Methods of Management Applied to Various Types of Industry, by Sanford E. Thompson, Mem.Am.Soc. M.E.; Scientific Management in the Operation of a Public Service Corporation, by Charles Day, Mem.Am.Soc.M.E., and An Illustrated Trip Through Scientifically Managed Factories, by H. K. Hathaway, Mem.Am.Soc.M.E.

The round table discussions will cover continuous manufacturing processes, including paper and pulp manufacture, textiles, books, clothing, boxes, envelopes, handkerchiefs and printing; non-continuous manufacturing processes, particularly machine shop practice; practically continuous processes, exemplified by automobile manufacture; construction work; store sales management and traveling sales management. Leaders in the round table discussions will be Keppele Hall, Mem. Am.Soc.M.E.; Robert B. Wolf, Mem.Am.Soc.M.E.; Henry V. R. Scheel, Mem.Am.Soc.M.E.; Arthur E. Barter, Richard A. Feiss, Mem.Am.Soc.M.E.; Frank R. Wallace, R. B. Fraser, D. J. Walsh, Jr., John H. Williams, Carl G. Barth, Mem.Am. Soc.M.E.; Com. Allen M. Cook, H. K. Hathaway, Mem.Am. Soc.M.E.; F. A. Parkhurst, Assoc.Am.Soc.M.E.; Albert R. Shipley, Assoc.Am.Soc.M.E.; F. F. Beall, Jun.Am.Soc.M.E.; J. C. Regan, Mem.Am.Soc.M.E.; W. B. Laine, Mem.Am.Soc. M.E.; Wm. O. Lichtner, Mem.Am.Soc.M.E.; John H. Scoville, Miner Chipman, T. K. Corey, H. A. Brown, John M. Bruce, Assoc.Am.Soc.M.E.; Henry T. Noyes, Assoc.Am.Soc.M.E., and R. Mayo-Smith.

M. L. Cooke, Mem.Am.Soc.M.E., will act as chairman at the closing session, which will be a summary and discussion.

The Richard A. Feiss Co., Clotheraft Shops, Cleveland, Ohio, will entertain visiting members on their way to the Congress, as will also the Executives' Club of the Detroit Board of Commerce.

JUNIOR AND STUDENT PRIZES

The Committee on Awards of prizes for papers contributed by Junior Members and members of Student Branches desire to call attention to the fact that the limiting date for sending in contributions for competition for these prizes is June 30.

One cash prize of fifty dollars and engraved certificate are available for the best paper of the year by a Junior Member, and four cash prizes of twenty-five dollars each, and engraved certificate, are available for the four best papers of the year by members of Student Branches.

Full information regarding these prizes and the Rules of Award are given in the 1916 Year Book. The Committee desire to emphasize that contributions should be typewritten in double spacing on paper of uniform size, preferably 8½ x 11 in., and with illustrations neatly drawn and tabulated matter clearly arranged; the whole should be enclosed in a binder. Papers must be the *bona fide* production of the contributor and must not have been previously made public.

The awards for 1916 will be announced at the Annual Meeting, December, 1916, and will also be published in The Journal.

CLASSIFICATION OF TECHNICAL LITERATURE

A meeting of the joint committee of the National Engineering Societies and leading technical and industrial organizations of the country, on classification of technical literature, was held in the council room of our Society on April 1. Henry W. Peck, Mem.Am.Soc.M.E., who has been actively identified with the movement from its inception, presented a progress report reviewing the work of the committee to date. W. P. Cutter, librarian of the United Engineering Society, presented a paper entitled How to Make a Classification.

Two general schemes of procedure were then presented,—the one to assign parts of the classification to organizations vitally interested therein, the final compilation and correlation to be performed by one central body under the supervision of an expert classifier; and the other to have classifiers or librarians intimately acquainted with present technical literature prepare classifications subject to revision by engineering organizations. After considerable discussion, it was decided to adopt the former plan. F. R. Low, Mem.Am.Soc.M.E., has resigned the chairmanship of the executive committee in favor of Henry W. Peck, Mem.Am.Soc.M.E.

INDUSTRIAL PREPAREDNESS

The names of the members of our Society selected by the Council from each of the states of the Union, the Territory of Alaska and the District of Columbia, to act as State Directors of the Organization for Industrial Preparedness and Associate Members of the Naval Consulting Board, have now been approved by the Secretary of the Navy and the appointments made. The Secretary of the Navy has also made the appointments in the cases of the four other great technical societies mentioned in the letter to the Society from the President of the United States, published in the February issue of The Journal, and the personnel of the organization is now complete.

Below are the names of the State Directors appointed from our Society, correct to April 16, 1916.

ALABAMA. F. H. Crockard, 1524 Brown-Marx Bldg., Birmingham, Ala.—V. P., Tenn. Coal, Iron & R. R. Co.

ALASKA. George A. Diamond, Nome, Alaska—Mngr., Scheid & Co.

ARIZONA. A. G. McGregor, Warren, Ariz.—Calumet & Ariz. Mining Co.

ARKANSAS. B. N. Wilson, Fayetteville, Ark.—Prof. Mech. Eng., Univ. of Ark.

CALIFORNIA. C. W. Merrill, 121 Second St., San Francisco, Cal.—Merrill Metallurgical Co.

COLORADO. T. B. Stearns, 1720 California St., Denver, Colo.

CONNECTICUT. H. B. Sargent, New Haven, Conn.—V. P., Sargent & Co.

DELAWARE. R. W. Smith, Wilmington, Del.—V. P., Hilles & Jones Co.

DISTRICT OF COLUMBIA. Dr. W. S. Stratton, Washington, D. C.—Director, Bureau of Standards.

FLORIDA. R. E. Chandler, Gainesville, Fla.—Prof. Mech. Eng., Univ. of Fla.

GEORGIA. Oscar Elsas, Atlanta, Ga.—Pres., Fulton Bag & Cotton Mills.

IDAHO. Geo. F. Waddell, Squirrell, Fremont County, Idaho.

ILLINOIS. Dr. W. F. M. Goss, Urbana, Ill.—Dean, Coll. Eng., Univ. of Ill.

INDIANA. Geo. O. Rockwood, 1801 English Ave., Indianapolis, Ind.—Pres., Rockwood Mfg. Co.

IOWA S. M. Woodward, Iowa City, Iowa—Prof. Mech., State Univ. of Iowa.

KANSAS. A. A. Potter, Manhattan, Kansas—Dean, Div. of Engineering, Kansas State Agric. College.

KENTUCKY. W. S. Speed, 325 West Main St., Louisville, Ky.—Pres., Louisville Cement Co.

LOUISIANA. A. M. Lockett, 533 Baronne St., New Orleans, La.—Pres., A. M. Lockett Co., Ltd.

MAINE. J. S. Hyde, Bath, Me.—Pres., Bath Iron Works.

MARYLAND. C. C. Thomas, Baltimore, Md.—Prof. M. E., Johns-Hopkins Univ.

MASSACHUSETTS. Ira N. Hollis, Worcester, Mass.—Pres., Worcester, Poly. Inst.

MICHIGAN. Alex Dow, 18 Wash. Ave., Detroit, Mich.—Pres. & G. M., The Detroit Edison Co.

MINNESOTA. J. J. Flather, Minneapolis, Minn.—Prof. Mech. Eng., Univ. Minn.

MISSISSIPPI. R. C. Carpenter, Agricultural College, Miss.—Prof. Mech. Eng.

MISSOURI. E. Flad, DeMenil Bldg., St. Louis, Mo.

MONTANA. C. V. Nordberg, 305 Elec. Bldg., Butte, Mont.—Nordberg Mfg. Co.

NEBRASKA. Wm. R. McKeen, 1222 Webster Ave., Omaha, Nebr.—Pres., McKeen Motor Car Co.

NEVADA. James G. Scrugham, Reno, Nev.—Dean Eng. College, Univ. of Nev.

NEW HAMPSHIRE. Thomas W. Fry, Claremont, N. H.—Secy., Sullivan Mchy. Co.

NEW JERSEY. H. L. Gantt, 2905 Singer Bldg., New York City.

NEW MEXICO. L. J. Charles, Elephant Butte, New Mexico—C. E., U. S. Reclamation Service.

NEW YORK. W. H. Marshall, 30 Church St., New York City—Pres., American Locomotive Co.

NORTH CAROLINA. Wm. S. Lee, Mercantile Bldg., Charlotte, N. C.—V. P. & Chf. Eng., Southern Power Co.

NORTH DAKOTA. Calvin H. Crouch, University, N. D.—Dean Coll. Mech. & Elec. Eng., Univ. of N. D.

OHIO. Frank A. Scott, 5701 Carnegie Ave., Cleveland, Ohio—V. P., The Warner & Swasey Co.

OKLAHOMA. J. P. Fisher, Bartlesville, Okla.

OREGON. Bert C. Ball, Portland, Ore.—Pres. & Mngr., Willamette Iron & Steel Works.

PENNSYLVANIA. Julian Kennedy, 1217 Bessemer Bldg., Pittsburgh, Pa.

RHODE ISLAND. Henry D. Sharpe, Providence, R. I.—Treas., Brown & Sharpe Mfg. Co.

SOUTH CAROLINA. J. L. Coker, Jr., Hartsville, S. C.—V. P., Carolina Fiber Co.

SOUTH DAKOTA. M. W. Davidson, Vermillion, S. D.—Prof. M. E., Univ. of S. Dak.

TENNESSEE. N. Sanders, Chattanooga, Tenn.—Newell Sanders Plow Co.

TEXAS. W. B. Tuttle, 305 E. Houston St., San Antonio, Tex.—V. P., San Antonio Traction Co. & San Antonio Gas & Elec. Co.

UTAH. Wm. Wraith, 618 Kearns Bldg., Salt Lake City, Utah—G. M., Internat. Smelting Co.

VERMONT. James Hartness, Springfield, Vt.—Pres., Jones & Lamson Mach. Co.

VIRGINIA. W. D. Mount, Saltville, Va.—G. M., Mathieson Alkali Works.

WASHINGTON. James V. Paterson, Seattle, Wash.—Pres., Seattle Constr. & Dry Dock Co.

WEST VIRGINIA. Chas. E. Ward, Box 647, Charleston, W. Va.—Pres., Charles Ward Eng. Works.

WISCONSIN. L. E. Strothman, Milwaukee, Wis.—Dept. Mngr., Allis-Chalmers Mfg. Co.

WYOMING. E. G. Hoefer, Laramie, Wyo.—Head Dept. M. & E. Eng., Univ. of Wyoming.

The next step to be taken is the organization of each State Board of Directors for business, and the selection in each state of a corps of field aides from the membership of the five societies within that state, to assist the boards in carrying out the plan of the industrial census as published in the March issue of The Journal.

Howard E. Coffin, Mem.Am.Soc.M.E., is chairman of the Committee on Industrial Preparedness of the Naval Consulting Board, under the direction of which the State Directors will work and to which they will report, and W. S. Gifford, statistician of the American Telephone and Telegraph Company, is supervising director of the work of the committee.

TRIBUTE TO DR. WOODBURY

At a meeting of the Board of Government of The National Association of Cotton Manufacturers, April 24, 1916, the following resolution was unanimously adopted:

The Board of Government desires to express its profound sorrow at the death of the Secretary of the Association, Dr. Charles J. H. Woodbury.

This Association, and the cotton industry in general, owes to Dr. Woodbury a debt which is unmeasurable. Devoting himself in early life to the problems of mill construction and fire protection, he has, during all his official connection with the Association, of upwards of twenty-five years, been the leader in all movements tending to improve the processes and methods of textile mills. Under the guidance of his trained, scientific mind, the Transactions of the Association have recorded in the fullest degree the development of the cotton industry in its technical, historical, and social aspects; and they stand as a worthy monument to his memory.

To Dr. Woodbury more than to any one man is due the continued growth and prosperity of the Association, and its value as a representative of the textile trade. In spite of severe physical disabilities during the last period, he has served its interests with fidelity and devotion, and it may be said with truth that he laid down his life in its service.

As individuals, we shall miss him, with his kindly personality, his unfailing courtesy, his broad culture, and his remarkable fund of information.

The Board of Government of The National Association of Cotton Manufacturers hereby resolves, as a tribute of affection and gratitude, that this resolution be entered upon its records, and that copies be sent to the bereaved family, to affiliated associations, and to the daily press.

ERICSSON MONUMENT

The Society has received a copy of Hearings before the Committee on the Library, House of Representatives, Sixty-fourth Congress, reporting the hearing on March 13, 1916, on the bill recently introduced in Congress to erect a monument to the memory of John Ericsson.

As stated in The Journal last month, seven members were appointed to represent the Society at this hearing. Four of these were able to attend, and the following are the speeches in favor of the bill made by two of them, Erik Oberg and Casimir von Philp, and as reported in the hearings:

STATEMENT OF MR. ERIK OBERG, OF NEW YORK, N. Y.

Mr. Chairman and gentlemen of the committee, while by accident of birth I come from the same country as John Ericsson I am here to-day to urge the passage of this bill, not in any way on that account, but simply to urge the passage of the bill as an engineer.

I am honored to be here to-day as the representative of one of the greatest engineering societies in the United States, The American Society of Mechanical Engineers. There are three other gentlemen in this group, who are here also representing that society. I am authorized by the Board of Directors of The American Society of Mechanical Engineers, an organization composed of 7,000 members, living in all parts of the United States, all of whom belong to the most prominent engineering societies in the country, to urge the passage of this bill.

The engineers of the country recognize that John Ericsson was one of the greatest engineering geniuses of the last century, irrespective of where he was born and irrespective of whatever his nationality may have been. He is recognized as one of the greatest, if not the greatest engineering genius of the nineteenth century, and it seems appropriate that the nation in which he carried out his greatest engineering inventions should erect a monument to him as well as to other men in other professions, who have done signal service to humanity. It seems fitting that a lasting monument should be erected to such a man.

There is no one in the city of Washington or in the United States whose convenience and whose every-day life is not influenced by the engineering inventions of John Ericsson. He has made life for humanity at large easier. The steamships that aptly plow the sea to-day, pass through the ocean much safer and easier because of the inventions of John Ericsson. Because of that fact, The American Society of Mechanical Engineers urges that this committee report this bill favorably to the Congress of the United States. [Applause.]

STATEMENT OF MR. CASIMIR VON PHILP, OF BETHLEHEM, PA.

Mr. Chairman and gentlemen of the committee, I do not speak as a Swede, or as an American, or as representing any other nationality. I only speak as a mechanical engineer.

The engineer is considered the master of the mechanical arts. We will find monuments erected to prominent men of all professions, to lawyers and to warriors, but what have we done for the man who makes the warriors' tools? Is there a single monument to the inventor of the warriors' tools? There is none. The engineer is the inventor of the warriors' tools, but we have done nothing for him, and as an engineer I ask that this bill be favorably considered, so that the engineers will be represented at least to some extent in the monuments erected to prominent men.

I want now to call your attention to the rewards received by engineers. We have the United States Patent Office, which is the protector of the engineer's inventions. This Patent Office has received revenue from the engineers who have applied for patents. A part of the revenue received by the Patent Office can be used for the erection of a monument to an engineer, the master of the mechanical art.

As an engineer in the Bethlehem Steel Co., I am associated with the class of engineers represented by John Ericsson. If we take the *Monitor* we will find that the basic features of our modern battleships are found in the invention of John Ericsson as it appeared in the *Monitor*.

The *Monitor* was the most perfect invention of any kind of battleship construction. That vessel in its time was absolutely invulnerable. The guns were splendidly protected by the armament of the turrets, and the overhang of the armor prevented any vessel of that time ramming the *Monitor*, and those things made that ship one of the most prominent inventions of that time.

A modern battleship can be sunk easily, as has been shown during the present war, but at that time the battleship of John Ericsson was nonsinkable by any method in use at that time. There was nothing in the line of warships that could stand against it.

As an engineer and a follower of John Ericsson, I ask for the passage of this bill, in order that the engineers may be included in that class of prominent men who have had monuments erected to their memory. [Applause.]

LECTURES ON MILITARY ENGINEERING

As anticipated, the movement inaugurated in New York by a committee of members of the national engineering societies for providing free lectures on military engineering subjects has spread beyond the metropolis.

In Detroit a course of five weekly lectures for engineers, by Col. M. M. Patrick and Major P. S. Bond, Corps of Engineers, U. S. A., was commenced on March 29.

In Chicago eleven weekly events, beginning on April 20, have been inaugurated. The first nine of these are Military Engineering lectures, and the remaining two excursions to a citizen's training camp to be established near Indianapolis. Correspondence courses and practical work in field engineering and maneuvers by members of the training camp are to be organized during the summer.

NOTES

The A.S.M.E. Boiler Code was presented by S. F. Jeter, Mem.Am.Soc.M.E., at the Annual Meeting of the National Association of Cotton Manufacturers, held in Boston, April 26 and 27. John R. Fordyce, Mem.Am.Soc.M.E., presented a paper on Cotton Handling in Southern Warehouses; Dr. S. W. Stratton, Mem.Am.Soc.M.E., presented a paper on Tests of Cotton Yarn and Fabrics, and Wm. D. Hartshorne, Mem.Am.Soc.M.E., presented a paper on The Washington Conference and Its Relation to Tire Fabric and Other Testing Requirements.

The Metropolitan District Student Branches are to be congratulated upon the success of their first joint meeting and smoker, which was held in the Engineering Societies Building on April 14, and an account of which is given elsewhere in this issue. The purpose of the meeting was announced to be "to bring the students into closer touch with the Society," but the real effect of this joint meeting was undoubtedly "to bring the students into closer touch, through the Society, with one another"—which was everything to be desired.

An informal discussion on the question "What relation should exist between the National Engineering Societies and the local section or association of their members; and, in the interests of the profession, what should be the attitude of both of the above to other local engineering societies or clubs?" was held by the American Society of Civil Engineers at their meeting of April 19. President D. S. Jacobus presented the subject from the standpoint of the experience of our Society. A report of the meeting which is of equal interest to all of our members will appear in a later issue of The Journal.

APPLICATIONS FOR MEMBERSHIP

TO BE VOTED ON JUNE 10, 1916

Members are requested to scrutinize with care the following list of candidates who have filed applications for membership in the Society. These are subdivided according to the grades for which their ages qualify them and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third class under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into Membership by advising the Secretary promptly of any one whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote. Unless objection is made by some member by June 10, 1916, and providing satisfactory replies have been received from the required number of references, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary about July 15, 1916.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

AFFLECK, MYRON H., Engr.,
Rumford Chemical Works, Providence, R. I.

ANDERSON, ARTHUR E., Supt.,
The Intermountain Rwy., Lt. & Pwr. Co., Laramie, Wyo.

BORGE, JOHN, Pres.,
Borge Incinerator Corp., New York City

BROWN, FRED W., Vice-Pres.,
Associated Engineering Co., Somerset, Ky.

BROWN, PERCY, Efficiency Engr.,
American Graphophone Co., Bridgeport, Conn.

CLEMONS, ROBERT S., Constr. Engr.,
Ambler-Davis Co., Philadelphia, Pa.

ELLIOTT, NEWTON R., Mech. Draftsman,
The Portland Co., Portland, Me.

FINLAY, WALTER S., JR., Constr. Engr., Motive Pwr. Dept.,
Interborough Rapid Transit Co., New York City

FITZGERALD, WALTER L., Asst. Works Mgr.,
Edward G. Budd Mfg. Co., Philadelphia, Pa.

FOQUE, THEODORE A., Genl. Mech. Supt.,
The Minneapolis, St. Paul & Sault Ste. Marie Ry. Co., Soo Line, Minneapolis, Minn.

HAYS, JOSEPH W., Cons. Engr., 1778 Estes Ave., Chicago, Ill.

HOLLIS, HENRY L., Cons. Mining and Metallurgical Engr.,
1025 Peoples Gas Bldg., Chicago, Ill.

HYDE, GLENN C., Engr. and Vice-Pres.,
Electric Transmission Co. of Va., Lexington, Ky.

JACOBY, HENRY E., Contr. Engr., 95 Liberty Street,
New York City

KANE, EDMUND J., Engr.,
Tractor Works, International Harvester Corp., Chicago, Ill.

KEMPTON, HERBERT E., Prod. Mgr.,
Van Blerck Motor Co., Monroe, Mich.

KITTREDGE, JOHN W., Development Dept.,
Firestone Tire & Rubber Co., Akron, Ohio

LEEDS, EDWARD L., Genl. Sales Mgr.,
Niles-Bement-Pond Co., New York

MACBRIAR, WALLACE N., Ch. Engr.,
Carnation Milk Products Co., Seattle, Wash.

MACFARLAND, D. H., Asst. to the Pres.,
The Atlas Portland Cement Co., New York City

MARROW, GEORGE P., Asst. Engr.,
Cons. Gas, Electric Light & Pwr. Co., Baltimore, Md.

MASSEY, FRANK L., Mgr. and Treas.,
Massey Machine Co., Watertown, N. Y.

MOWAT, J. F., M.M. of Blast Furnaces,
Illinois Steel Co., Joliet, Ill.

RAYBOULD, FRANK J., Foreman Assembling Room,
Winchester Repeating Arms Co., New Haven, Conn.

STEWART, SAMUEL, Mech. Engr. and Genl. Master Mech.,
Republic Iron & Steel Co., Thomas Sta., Birmingham, Ala.

TALKES, ERNEST B., Master Mechanic,
Federal Furnace Plant, By-Products Coke Corp.,
Chicago, Ill.

TITUS, WARREN H., Retired, Providence, R. I.

VAUGHAN, LILLIAN L., Asst. Prof. of Exper, Engrg.,
N. C. College of Agriculture & Mechanic Arts,
W. Raleigh, N. C.

WAGNER, CHARLES F., Mech. Engr.,
The J. B. McCrary Co., Atlanta, Ga.

WEBSTER, JOSEPH S., Mech. Engr.,
New Haven Boiler Works, New Haven, Conn.

WIGHTMAN, GEORGE H., Mech. Engr.,
Gorham Mfg. Co., Providence, R. I.

WILBER, DANA W., Prin. Asst. Engr.,
to Mr. H. M. Wharton, M.E., New York City

WILCOX, RALPH M., Civil Engr.,
of Wilcox & Lucey, Middletown, Conn.

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

BALL, HERBERT J., Instr. in Mech. Engrg. and Accounting,
Lowell Textile School, Lowell, Mass.

BARBOUR, ROBERT, Pres.,
Barbour Flax Spinning Co., Paterson, N. J.

BRYAN, MARCUS K., Mech. Engr.,
with John A. Stevens, Cons. Engr., Lowell, Mass.

CARBONE, MARIO G., Mgr.,
Italian-Swiss Colony, New York City

DE FLOREZ, LUIS, Chief Engr.,
Motor Petrol Co., Bayonne, N. J.

DISSTON, WILLIAM D., 3rd Vice-Pres.,
Henry Disston & Sons, Inc., Tacony, Philadelphia, Pa.

FORCE, HENRY H., Chief Engr. and Chief Electrician,
The Stanley Works, New Britain, Conn.

HOLMGREN, FREDERIC C., Material Engr.,
Remington Arms & Ammunition Co., Bridgeport, Conn.

KELLOGG, CHARLES D. H., JR.,
with Bridgeport Brass Co., Bridgeport, Conn.

LIPSNER, BENJAMIN B., Mech. Engr. and Supt. of Transportation,
Albert Pick & Co., Chicago, Ill.

LLOYD, SHERMAN C., Asst. Ballistic Engr.,
Expr. Sta., E. I. du Pont de Nemours & Co.,
Henry Clay, Del.

MORROW, LESTER, C., Inspector, Under U. S. Representatives of British Ministry of Munitions,
Gisholt Mch. Co., Madison, Wis.

NESTLER, PETER J., Asst. Engr.,
M. W. Kellogg Co., New York

ROGERS, FREDERICK E., JR., Cons. Engr.,
Good Housekeeping Inst., New York City

SAMPSON, EDWIN M., Supt.,
Armored Cable Dept., National Metal Molding Co.,
Economy, Pa.

STARBUCK, WILLIAM D. L., 746 St. Nicholas Avenue,
New York City

VANIMAN, ROY L., Pres.,
Produce Terminal Corp., Union Stock Yards, Chicago, Ill.

FOR CONSIDERATION AS JUNIOR

BLACKMER, WALDO H., Supvr. Inspection,
American Ammunition Co., Worcester, Mass.

BLOOD, LAURENCE E., Supt. Factory B, S. A. Woods Machine Co., Boston, Mass.
BOHN, ROBERT G., Draftsman, Illinois Traction System, Peoria, Ill.
BRADY, CHARLES V., Senior Student, Washington University, St. Louis, Mo.
BRANDT, HERMAN A., Student, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.
BROOKS, MALCOLM G., with M. S. Brooks & Sons, Chester, Conn.
BROWN, CLAUDE C., Asst. Boiler-room Chemist, Pacific Gas & Elec. Co., San Francisco, Cal.
CENTER, IRVING E., Asst. Engr., Turbine Research Dept., General Electric Co., West Lynn, Mass.
DOYLE, WILLIAM L. H. Engrg. Dept., Combustion Engineering Corp., New York City
FAIRCHILD, ILER J., Computer-Draftsman, Ordnance Office, War Dept., U. S. A., Washington, D. C.
GE BAUER, CLARENCE H., with General Elec. Co., Cincinnati, Ohio
GLENN, EDWARD R., Shop Supt., Electro Bleaching Gas Co., New York City
GROBLI, WALTER A., Instr., Dept. of Descriptive Geometry and Mech. Drawing, Stevens Inst. of Technology, Hoboken, N. J.
HAMILTON, KENNETH D., Mech. Engr., Geo. E. Keith Co., Campello, Mass.
HAINES, J. EDGAR, Supervising Draftsman, Duquesne Light Co., Pwr. Sta. Dept., Pittsburgh, Pa.
KELLER, CLIFFORD H., Engr., Rochester Trailer Co., Inc., East Rochester, N. Y.
MATTHEW, ROBERT M., Machine Shop Foreman, Ohio Tool Co., Charleston, W. Va.
MEHARD, HUGH R., with Ford Motor Co., Detroit, Mich.
NOVOTNEY, THOMAS A., Engr., Dept. of Research, American Radiator Co., Buffalo, N. Y.
PENROD, ESTEL B., Draftsman, Eclipse Motor Co., Cleveland, Ohio
ROLAND, PERCY W., Mech. Engr., Gadabout Motor Corp., New York City
RUTH, ROWLAND W., Engrg Dept., American Well Works, Aurora, Ill.
SCHMIDT, FRANK B., Asst. Supt., F. L. Schmidt Co., New York City
SEELBACH, EARL H., Designer, Pierce-Arrow Motor Car Co., Buffalo, N. Y.
SHARP, RALPH E., Chief Inspector, Worth Brothers Co., Coatesville, Pa.
SHERWOOD, HERBERT P., with The Kennicott Co., Chicago, Ill.
SMITH, CARROLL W., with C. A. Smith Lumber & Mfg. Co., Oakland, Cal.
SPEARMAN, JOHN M., Steam Engr., Mining Div., Tennessee Coal, Iron & R.R. Co., Blockton, Ala.
STRAHLMANN, OTTO E., Aeronautical Mech. Draftsman, U. S. Signal Corps Aviation School, San Diego, Cal.
VOOS, FREDERICK W., with Remington Arms & Ammunition Co., Bridgeport, Conn.
WELLING, LINDSAY H., with Henry R. Worthington, New York City
WESTBROOK, JAMES R., Student Apprentice, Westinghouse Air Brake Co., Wilmerding, Pa.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE-MEMBER

ASHLEY, EDWARD E., JR., Mech. and Elec. Engr., c/o Starrett & Van Vleck, Architects, New York City

PROMOTION FROM JUNIOR

ANDERSON, HOWARD L., Master Mech., American Sheet & Tin Plate Co., Vandergrift, Pa.
AVNSOE, THORKILD, Genl. Supt., Texas Portland Cement Co., Dallas—Houston, Tex.
HALLOCK, HOMAN F., Mech. Engr., The Diamond Match Co., Oswego, N. Y.
MURPHY, BENJAMIN S., Asst. Engr., Hudson & Manhattan R. R. Co., New York City
NAESS, RAGNVALD, Engr., American Trading Co., Manila, P. I.
OAKLEY, WALTER W., Standardization of Mfg. Practice, The Pittsburgh Plate Glass Co., Works No. 8, Kokomo, Ind.
SHENBERGER, GEORGE H., Draftsman, The Goulds Mfg. Co., Seneca Falls, N. Y.
WITHINGTON, SIDNEY, Asst. Engr., New York, New Haven & Hartford R. R. Co., New Haven, Conn.

SUMMARY

New Applications	81
Applications for change of grading:	
Promotions from Associate-Member	1
Promotion from Junior	8
Total	90

GEOGRAPHICAL INDEX

(Applications for promotion from any grade will be indicated by the initials of that grade.)

Alabama
Birmingham—Stewart, S.
Blockton—Spearman, J. M.
California
Oakland—Smith, C. W.
San Diego—Strahlmann, O. E.
San Francisco—Brown, C. C.
Connecticut
Bridgeport—Brown, P.
Holmgren, F. C.
Kellogg, C. D. H., Jr.
Voos, F. W.
Chester—Brooks, M. G.
Middletown—Wilcox, R. M.
New Britain—Force, H. H.
New Haven—Raybould, F. J.
Webster, J. S.
Withington, S. (J.)
Delaware
Henry Clay—Lloyd, S. C.
District of Columbia
Washington—Fairchild, I. J.
Georgia
Atlanta—Wagner, C. F.
Illinois
Aurora—Ruth, R. W.
Chicago—Hays, J. W.
Hollis, H. L.
Kane, E. J.
Lipsner, B. B.
Sherwood, H. P.
Talkes, E. B.
Vaniman, R. L.
Joliet—Mowat, J. F.
Peoria—Bohn, R. G.
Indiana
Kokomo—Oakley, W. W. (J.)
Kentucky
Lexington—Hyde, G. C.
Somerset—Brown, F. W.
Maine
Portland—Elliott, N. R.
Maryland
Baltimore—Marrow, G. P.
Massachusetts
Boston—Blood, L. E.
Campello—Hamilton, K. D.
Lowell—Ball, H. J.
Bryan, M. K.
West Lynn—Center, I. E.
Worcester—Blackmer, W. H.
Michigan
Detroit—Mehard, H. R.
Monroe—Kempton, H. E.
Minnesota
Minneapolis—Foque, T. A.
Missouri
St. Louis—Brady, C. V.
New Jersey
Bayonne—de Florez, L.
Paterson—Barbour, R.
Hoboken—Grobli, W. A.
New York
Brooklyn—Brandt, H. A.
Buffalo—Novotney, T. A.
Seelbach, E. H.
East Rochester—Keller, C. H.
New York City—Ashley, E. E., Jr. (A.M.)
Borge, J.
Carbome, M. G.
Doyle, W. L. H.
Finlay, W. S., Jr.
Glenn, E. R.
Jacoby, H. E.
Leeds, E. L.
MacFarland, D. H.
Murphy, B. S. (J.)
Nestler, P. J.
Rogers, F. E., Jr.
Roland, P. W.
Schmidt, F. B.
Starbuck, W. D. L.
Welling, L. H.
Wilber, D. W.
Oswego—Hallock, H. R. (J.)
Seneca Falls—Shenberger, G. H. (J.)
Watertown—Massey, F. L.
North Carolina
W. Raleigh—Vaughan, L. L.
Ohio
Akron—Kittredge, J. W.
Cincinnati—Ge Bauer, C. H.
Cleveland—Penrod, E. B.
Pennsylvania
Coatesville—Sharp, R. E.
Economy—Sampson, E. M.
Philadelphia—Clemons, R. S.
Disston, W. D.
Fitzgerald, W. L.
Pittsburgh—Haines, J. E.
Vandergrift—Anderson, H. L. (J.)
Wilmerding—Westbrook, J. R.
Philippine Islands
Manila—Naess, R. (J.)
Rhode Island
Providence—Affleck, M. H.
Titus, W. H.
Wightman, G. H.
Texas
Houston—Avnsoe, T. (J.)
Washington
Seattle—MacBriar, W. N.
West Virginia
Charleston—Matthew, R. M.
Wisconsin
Madison—Morrow, L. C.
Wyoming
Laramie—Anderson, A. E.

PERSONALS

THIS department is intended for items about members of the Society, their professional work and incidents concerning them which may be of interest to the membership in general. Items are solicited upon important engineering developments in which members have been associated, and also newspaper clippings or manuscripts of addresses delivered by members at meetings of any kind are desired. It is hoped that every member of the Society will furnish an interesting item occasionally for publication in The Journal.

H. L. Gantt is the author of a new book entitled Industrial Leadership.

C. B. Langstroth has become associated with the Ross Rifle Company of Quebec, Canada.

James I. Emery has been appointed chief engineer of the National Projectile Factory, Lancaster, England.

An article on the Lethbridge Municipal Power Plant by A. G. Christie is published in the April 4 issue of *Power*.

Robert B. Brownlee is co-author with Frederick G. Keyes of a book entitled The Thermodynamic Properties of Ammonia.

George H. Houston has become associated with the American Can Company in a consulting capacity, with headquarters in New York.

Willard F. Rockwell has contributed an article on The Organization of a Modern Foundry to the April 6 issue of *The Iron Age*.

Dr. Miller R. Hutchison, chief engineer of the laboratory of Thomas A. Edison, addressed the Jovian League of New York City on April 5.

George C. Olmsted, manager of the Minnesota Radiator Company of Duluth, Minn., has changed his headquarters to Minneapolis, Minn.

James A. Moyer and James P. Calderwood are co-authors of a book entitled Engineering Thermodynamics which has recently been published.

Charles P. Steinmetz spoke on general problems of illuminating design at the April 6 meeting of the Illuminating Engineering Society, New York.

An address on The Manufacture of Pulp and Paper by Lucien Buck was given at the March 17 meeting of the Rochester Engineering Society.

L. R. Pomeroy is the author of an article on Diameter of Driving Axle Journals, which appears in the April issue of *Railway Mechanical Engineer*.

W. F. Freund, formerly with the India Rubber Company of New Brunswick, N. J., has become a member of the staff of Gibbs and Hill of New York.

Arthur C. Scott is the author of an article on Lubrication of Station and Industrial Machinery which appears in the April 8 issue of *Electrical World*.

J. E. Johnson, Jr., has contributed an article on The Operation of the Blast Furnace to the April 1 issue of *Metallurgical and Chemical Engineering*.

A. Lewis Jenkins contributed an article on a Chart for Ratios for Speeds in Geometric Progression to the April 13 issue of the *American Machinist*.

George F. Swain, professor of civil engineering, Harvard University, Cambridge, Mass., is the author of a book entitled Conservation of Water by Storage.

C. T. Myers, engineer for the Timken-David Brown Company, Detroit, manufacturers of worm-driven truck axles, has been promoted to manager of the company.

Herman Jakobsson, consulting engineer of Washington, D. C., has become affiliated with the Midvale Steel Company of Philadelphia, Pa., as artillery engineer.

Wm. H. Wood is the author of a brief article entitled Safety First Railroad Rail System, which appears in the April issue of *Railway and Locomotive Engineering*.

F. B. and L. M. Gilbreth are authors of an article entitled Conserving the Worker's Health and Energy, which is published in the April 6 issue of *The Iron Age*.

H. M. Estabrook, president of the Barney and Smith Car Company, Dayton, O., has become affiliated with the Malm Machine Company of Dayton, O., as treasurer.

Dr. Alex. C. Humphreys, Past-President, Am.Soc.M.E., presented a paper entitled Reform and Regulation at the April 21 meeting of the Boston Society of Civil Engineers.

Herbert R. Davis is now connected with the Dominion Gas Company of Buffalo, N. Y. He was until recently in the employ of the Quapaw Gas Company of Bartlesville, Okla.

Arthur R. Carlyle, engineer with the Union Oil Company of California, San Francisco, has been transferred to Los Angeles, Cal., as engineer of the marine department.

Bradley Stoughton, Secretary of the American Institute of Mining Engineers, addressed the Philadelphia Foundrymen's Association, April 5, on Melting with Crude Oil in the Cupola.

Welles H. Sellew is now associated with the Canadian Car and Foundry Company, Kingsland, N. J. He was formerly in the employ of the Otis Elevator Company of New York, N. Y.

Harry E. Smallbone, president and superintendent of the Smallbone Manufacturing Company, Chicago, Ill., has become associated with the King Sewing Machine Company, Buffalo, N. Y.

Walter C. Beckjord has become affiliated with the Madison Gas and Electric Company of Madison, Wis. He was formerly in the employ of the St. Paul Gas Light Company, St. Paul, Minn.

Howard B. Howie, until recently associated with the Oriskany Ore and Iron Corporation, Reusens, Va., has become identified with the Canadian Copper Company, Cunickel, Ontario.

Oscar Segalowitz, formerly with the American Paper Goods Company, Kensington, Conn., has entered the employ of the Aetna Explosives Company, New York, in the engineering department.

Forrest W. Manker has accepted a position with the B. F. Sturtevant Company, Cleveland, O. He was until recently connected with the Moulton Engineering Corporation of Portland, Me.

S. S. Wyer is the author of an article on Principles of Natural Gas Leasehold Valuation which appears in the April issue of the Bulletin of the American Institute of Mining Engineers.

F. L. Gilman, assistant general superintendent of the Western Electric Company, Chicago, Ill., has been appointed one of the assistant chief engineers of the company, with headquarters in New York.

William H. Shirey, formerly connected with Smith, Hinchman and Grylls, Detroit, Mich., as draftsman, has entered the employ of McMeans and Tripp, consulting engineers of Indianapolis, Ind.

George S. Wilson has contributed an article to the April 4 issue of *Power* on Sawmill Waste in Suction Producer Plant which gives results of test with hogged mill waste, fir bark and Douglas fir cubes.

Walter J. Bitterlich has been appointed plant engineer of the Hood Rubber Company, Watertown, Mass. He was formerly connected with this company in the capacity of assistant master mechanic.

W. Clement Brooke, until recently inspector of the East Orange Water Department, has accepted the position of assistant construction engineer with the Interborough Rapid Transit Company.

Burton C. Fonda, until recently in the employ of the Thomas Crimmins Contracting Company, New York, has become associated with the General Electric Company of Schenectady, N. Y., in the turbine department.

L. Guy Long, until recently affiliated with the Fairbanks-Morse Electric Manufacturing Company, Indianapolis, Ind., as mechanical engineer, has accepted a position with The Gibson Company of the same city.

P. A. Beaman has been appointed assistant superintendent of George W. Prentiss and Company, Holyoke, Mass. He was formerly with the Manufacturers Equipment Company, Boston, Mass., as mechanical engineer.

Archibald Johnston, vice-president of the Bethlehem Steel Company, a graduate of the class of '89 of Lehigh University, was given a dinner April 7 at the Machinery Club, New York, by the members of the New York Lehigh Club.

Walter C. Lange has resigned his position of engineer's assistant with the Consolidated Gas Company of New York, and has accepted the position of superintendent of the Schmitt Manufacturing Company, Homestead, N. J.

J. W. F. Macdonald, until recently connected with the International Engineering Works of Framingham, Mass., as chief draftsman, has accepted the position of mechanical engineer with the Merrill Process Company, Boston, Mass.

Alonzo B. See, president of the A. B. See Electric Elevator Company, New York, has been elected vice-president of the Machinery Club of the City of New York, to succeed the late John A. Hill, publisher of the American Machinist.

Marcus B. Rascovich has accepted a position with the Mineral Products Corporation of Marysvale, Utah. He was until recently associated with the Jualin Alaska Mines Company, Jualin, Alaska, in the capacity of mechanical engineer.

Russell J. Neagle is now connected with the Condit Electrical Manufacturing Company of South Boston, Mass., in the capacity of salesman. He was formerly in the employ of the Edison Electric Illuminating Company of Boston.

Ross Anderson has resigned his position of factory superintendent with the Flannery Bolt Company, Bridgeville, Pa., and has accepted the position of factory manager with the Poole Engineering and Machine Company, Baltimore, Md.

Howard B. Clark has resigned his position as eastern representative of the McNaull-Boiler Manufacturing Company of Toledo, O., to accept the position of engineer of operation and maintenance with the National Carbon Company of Cleveland, O.

The city of Philadelphia, acting on the recommendation of The Franklin Institute, has awarded the John Scott Legacy Medal and Premium to Clement F. Street, vice-president of the Locomotive Stoker Company, for the Street locomotive stoker.

Theodore B. J. Merkt, until recently connected with the Pyrene Manufacturing Company, New York, as experimental engineer, has become associated with Westinghouse, Church, Kerr and Company, New York, in the capacity of assistant engineer.

A. C. Brown has been elected general manager of the Brown Hoisting Machinery Company of Cleveland, O., succeeding Richard B. Sheridan. Mr. Brown is also vice-president of the Brown Hoisting Machinery Company and has been assistant manager.

William L. Wotherspoon has become consulting mechanical and electrical engineer to the International Nickel Company, New York. He was until recently associated with the Canadian Mining and Exploration Company, New York, in the same capacity.

Walter Castanedo, for many years New Orleans representative of the Harrisburg Foundry and Machine Works, has been appointed district manager for the Ames Iron Works of Oswego, N. Y., with headquarters in the Hennen Building, New Orleans, La.

Charles A. R. Haynes has resigned his position as assistant engineer with the New York Steam Company, New York, to accept a position as supervisor of scheduling of the plant department of the Winchester Repeating Arms Company, New Haven, Conn.

Frank R. Wheeler, for the past ten years associated with the C. H. Wheeler Manufacturing Company on the Pacific Coast and Chicago, has returned to Chicago, as district manager of the Middle Western territory, with office in the Marquette Building.

M. R. Hull has resigned his position as superintendent of construction at the Washoe Reduction Works of the Anaconda Copper Mining Company, Anaconda, Mont., to accept the position of chief engineer of the Arizona Copper Company, with headquarters at Clifton, Ariz.

A. L. G. Fritz has accepted the position of superintendent of construction with Ford, Bacon and Davis at Kingsport, Tenn. He was until recently superintendent of construction of the New Burlington Power Station of the Public Service Electric Company, Burlington, N. J.

Axel C. V. Malm has resigned his position of superintendent with the Egry Register Company, Dayton, O., which position he held for the past four years, and has formed a new company under the name of The Malm Machine Company, Dayton, O., for the working out of a rotary punch press designed by Mr. Malm.

James McIlvrid, who for years was manager of the Cockburn Company and its successor, The Standard Gas Power Corporation, has retired from the latter concern and has opened a machine shop in Jersey City under the name of The Mutual Iron Works, where he is building a complete line of special machinery.

Charles L. Edgar, president of the Edison Electric Illuminating Company of Boston, and J. B. McCall, president of the Philadelphia Electric Company, have been appointed to represent the central-station industry on the campaign executive committee for the "America's Electrical Week" celebration next December.

Dr. Charles E. Lucke presented a paper before the Independent Oil Men's Association at a meeting held in New York on April 14, in which he advocated the use of kerosene as fuel for automobiles. His idea in general terms was to pre-heat the air and the kerosene to 300 degrees, the initial heat to come from a kerosene lamp.

Frederick Sargent, of the firm of Sargent and Lundy, Chicago, Ill., sailed from New Orleans, La., for Chile, S. A., on April 5. Mr. Sargent is making this trip in behalf of the Chile Exploration Company, a firm which is identified with the Guggenheim copper interests. He expects to return to Chicago in about two months.

Arthur Falkenau, vice-president of the Hooper-Falkenau Engineering Company, industrial engineers and architects, New York, has become acting consulting engineer of the Canadian Car and Foundry Agency, which is carrying on the production of munitions for Russia in eighty or more plants in the United States and Canada.

Reid Jones has resigned his position as designing engineer for Bartlett and Ranney, Inc., consulting engineers of San Antonio, Tex., and has formed a partnership with C. S. Thomas, Jr., of St. Louis, under the firm name of Thomas and Jones. This firm is under contract to construct the new $1,750,000 terminals of the M., K. and T. R. R. at San Antonio, Tex.

Carl M. Hansen, secretary and chief engineer of the department of accident prevention, inspection and merit classification of the Workmen's Compensation Service Bureau has resigned. Mr. Hansen has been with the Bureau for three years and in that time has developed and put into successful application the system of schedule rating in practically every compensation state in the Union.

E. C. De Wolfe is the author of an article on the Application of Correct Methods which appears in the April 1 issue of *Coal Age*. This article outlines the advantage realized from the use of a top cutter in a mine where both floor and roof are uneven and top coal must be left. Both wide and narrow work is performed by this machine and the expense of timbering is practically eliminated.

Richard B. Sheridan, general manager of the Brown Hoisting Machinery Company, Cleveland, O., has announced his resignation and has accepted a position with the American International Corporation whose offices are at 120 Broadway, New York. Before his departure from Cleveland to New York, Mr. Sheridan was tendered a banquet by former associates who presented him with a loving cup.

Henry Souther, vice-president of the Ferro Machine and Foundry Company, Cleveland, O., and past-president of the Society of Automobile Engineers, has severed his connection with that firm. His new affiliations have not yet been announced. Mr. Souther joined the Ferro organization in 1914, having been consulting engineer to the Standard Roller Bearing Company, Philadelphia, for the previous four years.

H. G. Stott, superintendent of motive power of the Interborough Rapid Transit Company, New York, has been retained as consulting engineer in connection with the large steam plant which the Buffalo General Electric Company is building to supplement its hydro-electric energy from Niagara Falls. This new plant will embody many advanced features, including a steam pressure of 275 lb. and an exceptionally high boiler rating.

George W. Martin, vice-president of the New York Service Company, and Jay G. De Remer, formerly manager of the general engineering department of the American District Steam Company at North Tonawanda, N. Y., have formed a partnership under the firm name of Martin and De Remer, with offices at 100 Broadway, New York, for general practice in public utilities and industrial plants. Mr. Martin will retain his interest in the New York Service Company as its vice-president.

NECROLOGY

HENRY WICK

Henry Wick was born in Youngstown, Ohio, on May 13, 1846. He received his early education in the schools of Youngstown and later spent two years at the preparatory school of Western Reserve College at Hudson, Ohio. He returned to Youngstown and after a very short time spent in his father's bank, he became manager of the Packard Coal Company which was then opening a mine about two miles west of Youngstown.

In 1877, Mr. Wick became treasurer and active manager of the Youngstown Rolling Mill Company. He later took the lead in purchasing the rolling mill at Warren on the failure of the pipe works there and became the head of the company which undertook its operation. Up to that time, Youngstown had had no steel plant, but in the summer of 1892 a determined effort was made by the leading manufacturers to establish one there. As a result of this, the Ohio Steel Company was formed and Mr. Wick was chosen as its head. In 1899, the Ohio Steel Company with several plants in other places joined in forming the National Steel Company of which Mr. Wick became the first vice-president with headquarters in Chicago, Ill. A year later the offices were moved to New York City and early in 1901, Mr. Wick was elected president. He resigned this position shortly afterwards, however, and returned to Youngstown to take up some enterprises in which he was particularly interested.

Mr. Wick became a member of this Society in 1893. He died at his home in Youngstown after a short illness on December 22, 1915.

ALASTAIR ROSS

Alastair Ross was born in Aberdeen, Scotland, on July 1, 1888. He received his early education in the High School and at Gordon's College at Aberdeen and at the West of Scotland Technical College in Glasgow. He served a four years' apprenticeship with Messrs. J. Abernethy and Co., Engineers, in Aberdeen, in fitting and erecting marine engines, in general mill work and one year in the drafting room. From 1910-1911, he was a draftsman with the Harvey Engineering Company in Glasgow, sugar machinery specialists. He left this firm to become chief draftsman for Messrs. Catton, Neil and Co. in Honolulu, Hawaii. In 1913, he became head of the Engineering Department of Findlay Richardson & Company of Manila, Philippine Islands, and the next year went to Cuba as chief engineer for The Guantamo Sugar Company. He left Cuba in August, 1915, to take part in the War and obtained a Commission as Second Lieutenant in the Royal Flying Corps. He was killed in an aeroplane accident in Catterick, Yorkshire, on January 17, 1916. He became a member of this Society in 1915.

ROBERT ALLISON

Robert Allison was born at Middletown, Durham County, England, on December 25, 1827, but was brought to this country by his parents when very young. He received his early education in the schools of Shamokin, Northumberland County, Pa., which were taught by farmers for four months during the year.

At the age of 15, Mr. Allison was appointed an assistant engineer at the Shamokin furnace and the next year, he was apprenticed to the firm of Haywood & Snyder, Pottsville, Pa., to learn the trade of machinist. For about two years follow-

ing the completion of his apprenticeship, he worked as a journeyman, following which he accepted a position as foreman in the shops of T. H. Wintersteen, Port Carbon, Pa., where he introduced and developed many improvements in the shops, one in particular being a tool for boring car wheels. This machine did five times as much work as that done by the old method.

About 1863, Mr. Allison in partnership with F. B. Bannan of Pottsville, Pa. started the Franklin Iron Works of Port Carbon which had been idle several years. One of the most important inventions of this company was the Allison Cataract Steam Pump which revolutionized the system of freeing the underground mines from water. Another important invention was the hydraulic feed for diamond drilling machinery.

In 1878, Mr. Allison purchased Mr. Bannan's interest in the works and operated them alone until the time of his retirement in 1901.

Mr. Allison was a member of several Masonic lodges, a member of the Historical Society of Schuylkill County, the Schuylkill Motor Club and the American Institute of Mining Engineers. He became a member of this Society in 1884. He died at his home in Port Carbon on February 3, 1916.

THOMAS I. STEPHENSON

Thomas I. Stephenson was born in Lenoir City, Tennessee, November 5, 1863, and received his early education in the schools of Knoxville. He began work with the Knoxville Iron Company in 1880 and in 1891 was made its secretary. He was elected vice-president and general manager in 1895 and president and general manager in 1910. He was elected president of the Cross Mountain Coal Company in 1914. Mr. Stephenson became a member of this Society in 1915. He died at his home in Knoxville on January 18, 1916.

EDWARD I. LEIGHTON

Edward I. Leighton was born in Birmingham, England, on March 8, 1850. He moved to this country with his parents when about six years old, settling in Cleveland, where he attended the public schools. Prior to 1880 Mr. Leighton was employed in the steel mills of Cleveland. In that year, with Fred W. Bruch, he started the Cleveland Punch & Shear Works Company, first operated under the firm name of Leighton and Bruch. About 1890 Mr. Leighton purchased his partner's interest and later the business was sold. Although he retired from business 15 years ago, he had been director up to the time of his death in the following concerns: Acme Machinery Company, the Forest City Live Stock and Fair Company, the Van Dorn & Dutton Company, the Van Dorn Electric Tool Company and the Reliable Machine Company.

Mr. Leighton became a member of this Society in 1892. He died at St. Augustine, Fla., on February 26, 1916.

GEORGE W. K. TAYLOR

George W. K. Taylor was born in New York City on December 18, 1856. He received his early education in the public schools of Brooklyn and later attended Cooper Union from which he received a B.S. degree in 1877 and a degree in mechanical engineering in 1907. From 1874-1893 he was employed by the Eaton, Cole & Burnham Co. at New York and Bridgeport, Conn., in charge of the designing, manufacturing and superintending the production of special valves, fittings, etc., especially adapted to high pressure steam work for power stations. In 1893, he formed a partnership with Mr. McMann, and this firm made a specialty of designing, manufacturing and superintending work for power plants. In 1894, he equipped the steam power plants of the Baltimore, Md., traction system, and the Columbus, O., Edison Electric Light Co. This firm was incorporated in 1910 as the McMann & Taylor Company, designing and manufacturing wrought and cast iron pipes, boiler tubes, fittings, valves, tools, etc., and all goods pertaining to steam, water, gas, etc.

Mr. Taylor was a member of the Machinery Club of New York, the Society of Old Brooklynites, the Chamber of Commerce, the Merchants' Association, the Old Union League Club of Brooklyn, Director of Greenwich Bank, Trustee of St. John's Methodist Episcopal Church of Brooklyn, and was a 32nd degree Mason. He became a member of this Society in 1906.

He died at his home in Brooklyn, March 7, 1916.

WM. H. FRANCIS

Wm. H. Francis died in Philadelphia on March 16, 1916.

GEORGE NEWBOLD COMLY

George Newbold Comly was born at Byberry, Philadelphia, Pa., on August 6, 1851. He was educated at the Friends' School at Byberry and also at the Friends' Central School in Philadelphia, and served an apprenticeship in the machine shop of Wm. B. Bement & Sons in Philadelphia for four years. Following this, he was foreman of the machine shop at the Edge Moor Iron Works and later was put in charge of the drawing room.

In 1890, Mr. Comly started an engineering business for himself, doing considerable business for the Newport News Ship Building and Dry Dock Company.

In 1896, he became connected with the Solvay Process Company of Syracuse where he was in charge of the engineering department for fourteen years. For two and one half years preceding his death, he was Deputy Commissioner of Buildings for the city of Syracuse.

Mr. Comly was a member of the Citizen's Club, The Technology Club, the Syracuse Country Club, and the Social Literary Club, all of Syracuse. He was also a director of the Society for the Prevention of Cruelty to Children. He became a member of this Society in 1880. He died at his home in Syracuse on March 22, 1916.

HAROLD B. KIRKUP

Harold B. Kirkup was born on September 14, 1887. He received a degree of mechanical engineering from Cornell University in 1912. In September, 1912, he entered the employ of the Cambria Steel Company of Johnstown, Pa., doing general power plant work, including steam engine testing, indicating and valve setting. For two years preceding his death he was with the Ice Manufacturing Company of New York City as testing engineer. Mr. Kirkup became a member of this Society in 1914. He died in New York on March 23, 1916.

CLAUDE M. DUGAN, JR.

Claude M. Dugan, Jr. was born in Philadelphia, Pa. on February 3, 1877. He received his education at the Boys' Manual Training School and at the University of Pennsylvania, from which he graduated in 1898.

In 1899 he entered the employ of the Vulcanite Portland Cement Company as a chemist. Following this, he was employed by Wm. Krause Son Cement Co. and by the Bureau of

Filtration in Philadelphia. In 1905, he became assistant superintendent of the Kosmos Portland Cement Co. at Kosmosdale, Ky. and later manager of the manufacturing department. In 1911 he became general manager of this company. In 1913, he became president of the Dugan Engineering Company which was afterwards absorbed by the Hunt Engineering Company. For this latter company he was vice-president.

Mr. Dugan became a member of this Society in 1913. He died on April 11, 1916.

JAMES F. WALSH

James F. Walsh was born in Cleveland, Ohio, on March 29, 1857. He received his education in the parochial schools and Spencerian College of Cleveland. In 1871 he began railroad work as machinist apprentice on the Cleveland, Columbus, Cincinnati and Indianapolis Ry. and was successively locomotive fireman, engineer, and roundhouse foreman and general foreman.

In 1892 Mr. Walsh became associated with the Galena Signal Oil Company as mechanical expert and in 1902 he was appointed superintendent of motive power, Chesapeake and Ohio Railway, at Richmond, Virginia. In May, 1910, he became general superintendent of motive power for the Chesapeake and Ohio lines. He retired from active service in July, 1912.

At the time of his death, which occurred on April 13, 1916, at Roanoke, Virginia, Mr. Walsh was doing special mechanical work for the Galena Signal Oil Company. He became a member of this Society in 1913.

SOCIETY MEETINGS

It is of the highest importance in the development of the monthly meetings of the Society, both of the Sections and of the Student Branches, that comprehensive reports of these meetings be published in The Journal regularly. Secretaries of the sections and student branches are urged to make every effort to get the complete reports of their meetings to this office as quickly as possible after the meetings are held, and also where possible, copies of the papers presented should be sent in; if desired, the copy of the paper will be returned after examination. The reports of meetings in order to appear in the next issue of The Journal must be received in this office, before the 18th of the month.

NEW YORK, MARCH 29

The first social event to be held by the New York section, at which no effort was made to combine business with pleasure, took place at the Machinery Club on March 29. There was an attendance of nearly 200 members and ladies. A dinner was served, followed by dancing. Edwin J. Prindle, chairman of the Entertainment Committee, was toastmaster, and brief speeches were made by F. R. Low, Editor of Power, Spencer Miller, member of the Naval Consulting Board, and Secretary Calvin W. Rice. The speakers all entered into the spirit of the occasion, which called for story-telling rather than more serious discussion, and the whole affair was one of enjoyment and a delightful entertainment for all. By means of this meeting, the New York members, who usually have to rush for a train at the close of their evening meetings, became much better acquainted than has heretofore been possible, and the affair afforded so much pleasure that it is likely to become at least an annual event, and will, undoubtedly, lead to other social occasions in the way of smokers or excursions.

BUFFALO, MARCH 29

A meeting of the Engineering Society of Buffalo was held on March 29 at which Major L. V. Frazier of the United States Corps of Engineers gave a stereopticon lecture on The Engineering Arm of Our Army. Major Frazier said that the United States has about 2000 engineers to an army of approximately 80,000 men. In Europe, he said, the proportion of engineers is about twice that of the United States. He described the duties of the engineering corps as construction and demolition, and illustrated his points with figures. It builds and operates railways, mines bridges, trenches and fortifications; the participation of engineers in warfare is not limited to actual work with the fighting forces. Major Frazier said that examinations were open to junior and assistant engineers and to graduates of recognized engineering schools, and showed with a series of slides the training that they receive in preparation for them. Some of the views were of actual work at West Point, in Philadelphia and in Russia. A raft made of barrels to take the place of pontoons he referred to as a common expedient. The paper was discussed by Col. Charles Wolf of the 74th Regiment, who said that the country is talking too many kinds of preparedness, it should decide on one kind and go ahead with it, and Capt. W. E. Welsh of the 30th United States Infantry, who said that to go into war without a trained army, we should have to put 2,000,000 men in the field to secure suitable training for 1,000,000.

Two resolutions were carried unanimously. The first was presented by D. C. Howard, Mem.Am.Soc.M.E., and demanded that our representatives in Congress "act in accordance with the views expressed" in it which were that the country should be put in a condition of defense both on the Atlantic and Pacific coasts. The other was introduced by F. A. Lidbury of Niagara Falls, former president of the Electro Chemical Society of the United States. His resolution provided that this nation should so permit and foster development of its water power as to prevent further exportation of the electro chemical industry, on which military preparation fundamentally depends. There were about 250 members present.

BOSTON, APRIL 5

A meeting of the Boston Section of the Am.Soc.M.E. was held on April 5 at the Franklin Union. The subject of the meeting was The Shoe Industry, which was presented by Joseph J. Gillespie. The lecture was illustrated with lantern slides and moving pictures which showed the shoes of the primitive man and of the various countries and centuries, and also methods of shoe manufacture and the progress that has been made up to the present time.

NEW HAVEN, APRIL 5

The Spring Meeting of the New Haven Section held on April 5, was a joint meeting with the Civil, Electrical and Mining Engineers of New Haven. The meeting consisted of an afternoon session, held in the Mason Laboratory of the Sheffield Scientific School, dinner at the Yale Dining Club Hall, and an evening session in North Sheffield Hall. About 150 were present in the afternoon and about 300 in the evening.

Dr. L. P. Breckenridge, Mem.Am.Soc.M.E., presided in the afternoon, when H. I. Harriman, C.E., of Boston, Mass., presented an interesting paper on The Water Powers of New England. The paper was illustrated with numerous lantern

slides showing recent examples of drains, impounding reservoirs and hydro-electric plants in various parts of New England.

This paper was followed by a general discussion, which was opened by R. J. S. Pigott, Mem.Am.Soc.M.E. John W. Lieb, Mem.Am.Soc.M. E.; S. F. Ferguson, Mem.Am.Soc.M.E.; Prof. C. F. Scott, Mem.Am.Soc.M.E.; C. R. Harte, W. S. Huson, Mem.Am.Soc.M.E., Professor Breckenridge, and others took part in the discussion.

Calvin W. Rice, Secretary Am.Soc.M.E., was present and spoke for a few moments upon the work that the Society is doing in coöperating with the other national engineering societies toward the welfare of the country.

Following this session, a dinner was served in the hall of the Yale Dining Club. The evening session was opened by President Arthur T. Hadley of Yale University. President Hadley introduced Samuel Insull, president of the Commonwealth Edison Company of Chicago, who presented a comprehensive paper on The Progress of Economic Power Generation and Distribution. Mr. Insull reviewed the history of the business of electric power generation and distribution, from its inception in the early ages to the present time. His paper was illustrated by numerous lantern slides showing the evolution of electric power station machinery.

A more complete account of this meeting is given elsewhere in this issue.

PHILADELPHIA, APRIL 10

On April 10 a joint meeting of the Philadelphia Section of The American Society of Mechanical Engineers and of the American Institute of Electrical Engineers was held at the Engineers' Club, at which Joseph Tracy, Chairman of the Philadelphia Section of the A.I.E.E., and Prof. R. H. Fernald, Mem.Am.Soc.M.E. and Chairman of the Philadelphia Section of the Am.Soc.M.E., presided jointly. The general subject of the evening was Some Prime Movers Now Under Development. The first paper given was The Uniflow Engine, which was presented by Allan D. Skinner, Mem.Am.Soc.M.E., of the Skinner Engine Co., Erie, Pa. The second paper, on Future Possibilities of the Large Steam Turbine Generator in electric generating service, was presented by W. C. Eglin, Mem.Am. Soc.M.E., vice-president and chief engineer of the Philadelphia Electric Co. His paper was discussed by George R. Henderson, Mem.Am.Soc.M.E.; Carl Hering and R. H. Fernald, Mem. Am.Soc.M.E. The last paper, on The Diesel Engine, prepared by L. B. Harris, of the Southwark Foundry & Machine Co., was presented by W. B. Piersol, of the Southwark Foundry & Machine Co., as Mr. Harris was unable to be present. This paper was discussed by J. Woodbridge, T. M. Chance, Mem. Am.Soc.M.E.; H. P. Liversidge, H. T. Moore, Mem.Am.Soc.M. E.; Prof. Fernald and others. There were about 240 members present.

On behalf of Mr. Harris, Mr. Piersol extended an invitation to all present to visit the Southwark Foundry & Machine Co. to see the Southwark Diesel engines under construction.

BUFFALO, APRIL 12

A meeting of the Engineering Society of Buffalo was held on April 12 at which Fred Kent, works manager of the Lodge & Shipley Company of Cincinnati, Ohio, spoke on Bringing a Shop Up-to-Date.

Mr. Kent's talk was very practical and dealt with the establishment of a proper drafting room system, planning department, proper means for training of men and a means for routing work through the shop. He dealt in considerable detail with the question of when it paid to make jigs and when it did not; also, with the points of advantage of automatic lathes or plain engine lathes to the small shop man. About 250 members were present.

NEW YORK, APRIL 20

The New York Local Section held a joint meeting with the Metropolitan Section of the Society of Automobile Engineers in the Auditorium of the Engineering Societies Building on the evening of April 20. About 350 were present.

H. R. Cobleigh, chairman of the Am.Soc.M.E. Section, opened the meeting and invited Leonard Kebler, chairman of the S.A.E. Section to take the chair.

The topic of discussion was the four-cylinder vs. the multi-cylinder motor. Finley R. Porter, Mem.Am.Soc.M.E. and M.S.A.E., read a paper on Internal Combustion Motors; The Four-Cylinder Motor of To-day and Future Possibilities, and J. Edward Schipper, M.S.A.E., read a paper on Automobile Applications of Four-Cylinder Motors, prepared by F. E. Watts, M.S.A.E., who was unable to be present.

The keynote of Mr. Porter's paper was that the increase in number of cylinders of an engine has been the result of a demand in advance of the art, and that the determining factor of number of cylinders is thermal efficiency.

Mr. Watts' paper considered the requirements of performance, durability and maintenance cost of the motor of pleasure automobiles and pointed out how the four-cylinder motor met these requirements.

The case of the four-cylinder motor having been presented in the two papers, the chairman called for discussion of the other side of the question, and several members responded with interesting observations.

Preceding the meeting an informal dinner was held, at which members of both societies were present.

STUDENT BRANCHES

JOINT MEETING OF METROPOLITAN STUDENT BRANCHES

For the first time in the history of the Society a joint meeting of Student Branches was held at the headquarters of the Society on Friday evening, April 14, 1916. Five Student Branches located at the following institutions participated:

Columbia University
New York University
Pennsylvania State College
Polytechnic Institute of Brooklyn
Stevens Institute of Technology

More than 250 undergraduates and members of the Faculty of the various colleges were in attendance.

The meeting opened with an address of welcome by Past President and Honorary Secretary F. R. Hutton, who is also Chairman of the Committee on Student Branches. Professor Hutton pointed out the importance of the occasion and the fact that future joint meetings would be governed in a sense by the precedents formed on the occasion of the initial affair. The object of the meeting was to bring the students of the different engineering schools into closer touch with the parent Society and at the same time foster the habit of forming new acquaintanceships and friends among those in the engineering profession. In turn this develops the coöperation which is of paramount importance to the continued progress of the profession.

It is planned to make this joint meeting of the Student Branches located in the Metropolitan District an annual affair, and further that whenever possible the branches in other sections of the country will arrange to hold occasional joint meetings. This can be done either where several branches are conveniently located to one another, as is the case in New York,

or on occasions when one or more groups of engineering students are visiting other cities for trips of inspection or other purposes. The student members at Pennsylvania State College were in New York on a trip of inspection and the committee in charge of the meeting invited them to be their guests. It is planned to organize the meeting sufficiently early next year to make it possible for some of the other out of town Student Branch members to join in the meeting.

The manufacture of steel, tin plate, and tin products was shown by motion pictures loaned by the United States Steel Corporation. A motion picture showing the welding of a broken rudder plate followed with an actual demonstration of thermit welding of two pieces of pipe. This was most spectacular and was described by Mr. Hurlbert of the Goldschmidt Thermit Company.

All those in attendance were provided with cards showing the college they attend and with space for each to write his name. These were attached to the coat lapels.

A smoker and refreshments followed in the rooms of the Society and all joined in college songs led by the members of the glee clubs of the schools. Good fellowship prevailed generally and the following members of the committee in charge felt well repaid for the efforts which they put forth to make a success of the undertaking:

Lawrence H. Nielsen, Columbia University, Chairman
Herman Brandt, Polytechnic Institute of Brooklyn.
Charles A. Pines, New York University
James A. Wilcox, Stevens Institute of Technology.

ARMOUR INSTITUTE OF TECHNOLOGY

The Armour Institute of Technology Student Branch held a meeting on March 16, 1916, and Prof. Geo. F. Gebhardt, Mem.Am.Soc.M.E., carried out a novel plan. At his suggestion, the members considered themselves as consulting engineers and he acted as a client who was bringing several specimens of apparatus to be tested. A pair of small gears made of a special alloy were tested for failure. Other specimens were an automatic sprinkler and a piece of rubber hose. Many interesting points about the thoroughness with which the articles are tested were brought out.

Plans were discussed for conducting a meeting in the form of a court trial in which the defendants and plaintiffs would be composed of the students, the subject of the suit being the failure of some article with which engineers have to deal.

A meeting of the Student Branch was held on April 12 at which the following officers were elected for the coming year: L. A. King, president; Geo. Fritze, vice-president; E. W. Haines, secretary; H. S. White, treasurer. Plans were discussed for a banquet to be held on April 29. Following the speeches given by the new officers, a talk on Boiler Room Efficiency was given by G. F. Wetzel, a Senior who is employed by the International Filter Company of Chicago.

BUCKNELL UNIVERSITY

A meeting of the Bucknell University Student Branch was held on April 10. The speaker of the evening was unable to be present and the meeting was given over to an impromptu discussion of the subject of Safety Devices. The paper on Standardization of Safety Principles by Carl M. Hansen, published in the April issue of The Journal, was referred to in a number of instances and many instructive points were brought out by the students.

COLORADO AGRICULTURAL COLLEGE

The Colorado Agricultural College Student Branch held a meeting on February 28. Mr. Conrey gave a detailed and instructive talk on the Diesel Engine mentioning the advantages of the engine and its construction, and also giving an account of the discovery of the Diesel principle.

The meeting on March 13 was visited by members of the local branch of the A.I.E.E. and several sophomore engineering students. President Lory was the speaker of the evening and discussed the subject of Strengthening the Engineering Departments of the Land Grant Colleges. He said that in the early years of these colleges the engineering department threatened the life of the agricultural work. This fact caused considerable agitation and brought about the organization of the National Association of Agricultural Colleges and Experiment Stations. This movement surprisingly strengthened the standing of the agricultural departments and after several years the engineering department lost favor and seemed to be rapidly declining. This state of affairs continued to exist until only a few years ago an attempt was made to do away with the engineering department in the Land Grant Colleges through legislation. This led to protective measures on the part of that department and through organization, great strides have been made toward strengthening its stand. It is now planned to establish engineering experiment stations at these schools and thereby increase materially the value and usefulness of the engineering courses. Dr. Lory pointed out several important phases of the matter which should be followed up and spoke of the work already done by some of the larger institutions. In conclusion he painted a very bright picture of the future of engineering in the Colorado college.

At a meeting of the Branch on March 27, a series of four films were shown entitled From Ore to Finished "National Pipe." These pictures very clearly illustrated the mining, shipping and handling of the iron from the fields to the finished product of steel pipes. One reel was devoted to the welfare work of the National Tube Co.

LEHIGH UNIVERSITY

At a meeting of the Student Branch of Lehigh University held on March 23, William D. Reese spoke on Exhaust Steam Turbines. Mr. Reese explained that steam turbines are divided into two classes, those that take steam at boiler pressure and those that take steam from the exhaust of some type of reciprocating engine. Due to the increased cost of fuel and labor, engineers have turned their attention to devising some way by which more of the heat which the burning of a pound of coal generates can be used. There are ways of using a part of this latent heat, such as heating the feed water to a fairly high temperature by the exhaust steam, but these are not very satisfactory as not much of the heat can be recovered. For this reason engineers have tried to devise some form of engine which will use this latent heat in the exhaust steam, and of all the devices up to the present time the exhaust steam turbine has proved to be the most successful.

Mr. Reese gave a brief history of the exhaust steam turbine and presented data indicating the saving realized from its use. He said that an idea of the cost of these turbines may be gained from the cost equations given in *Power* for December, 1913. It has been found that where more power has been needed, that the cost of installation of the low pressure turbine system including the condenser to a reciprocating engine is less than that of an additional engine and boiler to generate the extra power, not counting the saving in fuel by the former. Although this turbine has not been developed to any extent in this country, there seems to be a great future for it in the extension of existing power plants.

G. P. Nachman, M.E., '14, who is in charge of the Heating and Ventilating department for S. B. Austin Sons & Co., of Cleveland, Ohio, spoke on Heating and Ventilating. Mr. Nachman first discussed the heating and ventilating of schoolhouses and enumerated the several methods of heating a building: namely, hot water either gravity or forced method, direct steam, either vacuum or return pipes, gas heaters, or the blower system.

Mr. Nachman said that it is advisable to heat large houses by the blower system. Therefore a one-unit system has been devised which not only heats the house but also ventilates it. A device is on the market consisting of a small motor which can be put out of a window and will draw air in the room over a radiator. The blower system is also used in mines and in the drying room. It was pointed out that the blower system has an advantage over the steam system in that the ordinary height of a window sash above the floor is 4 ft.; if steam is used, this space is taken up by steam coils, while if the blower system is used this space is clear and work benches, etc., may be placed there. The blower system is usually considered to be superior to any other form of heating or ventilating.

LELAND STANFORD JR. UNIVERSITY

The Student Branch of Leland Stanford, Jr., University held a meeting on March 1 at which H. C. Parker read a paper

describing the San Bernardino Precooling Plant, operated by the Santa Fé Railroad for cooling oranges before shipment. The packed oranges are cooled from a temperature of 60 to 90 deg. down to about 44 deg. This is accomplished by passing air refrigerated to a temperature of 8 to 10 deg. through the car packed with oranges. Eight thousand cubic feet per minute is the volume used and the cooling is continued for four hours. The balanced system is used with a pressure of ½ in. of water applied to one end of the car and ½ in. of vacuum to the other end. The flow is reversed every few minutes for uniform cooling.

The cooling system comprises three 350 h.p. Stirling boilers supplying steam to two cross compound engines, each direct connected to a 300 ton, 17 x 34 in. duplex, double acting Vilter refrigerating machine. The ice boxes of the cars are also filled with ice to maintain a low temperature during shipment.

The plant uses eight double inlet sirocco fans, each about 10 ft. in diameter. Each set of four fans is driven by an 80 h.p. motor. The eight fans will handle 260,000 cu. ft. of air per minute. The capacity of the plant is 32 cars every four hours.

The plant was erected by the Santa Fé Railroad in 1910 at a cost of $900,000. Since its installation over 30,000 cars of oranges have been precooled for shipment with the result that damage claims have been practically eliminated.

At the same meeting H. R. Hammett gave a paper on The Uses and Properties of Aluminum Alloys. The aluminum magnesium alloys were spoken of in particular, because of their present and future use in the automobile industry.

At a meeting of the Branch on March 15 an illustrated paper on Hydraulic Power Plant Engineering was presented by J. W. Swaren of the Pelton Water Wheel Co. of San Francisco. The history of the development of water wheels and turbines was first considered and then illustrations of modern practice were given. The lecture was generously illustrated with slides showing representative examples of modern installations.

OHIO STATE UNIVERSITY

A meeting of the Student Branch of the Ohio State University was held on February 16. It was decided to hold weekly meetings at which one member of each thesis group should give a short talk on his thesis subject, explaining the object of same and method of attaining it.

Steam Consumption from Indicator Cards was discussed by H. H. Brooks with special reference to more recent ways of improving the accuracy of this method.

PENNSYLVANIA STATE COLLEGE

The Student Branch of the Pennsylvania State College held a meeting on March 16, at which Professor Canan gave an illustrated talk on The Combustion of Fuels, showing the progress made in raising the efficiency of fuel utilization.

Prof. Frank A. Burr, Mem.Am.Soc.M.E., followed with an interesting and thorough discussion on Spray Pond Systems, giving costs and much valuable data on systems which have been installed.

UNIVERSITY OF CALIFORNIA

The University of California Student Branch held a regular meeting on the evening of March 21, at which K. Potts, '17, presented a paper on The Electric Drive on the Battleship *California*. He discussed the various possibilities of the electric method of ship propulsion and cited tests that have been carried out on the collier *Jupiter*.

Prof. J. N. LeConte, Mem.Am.Soc.M.E. and Honorary Chairman of the Branch, discussed the subject of Skin Friction on Centrifugal Pump Runners and Runner Balancing. He referred to tests which have been carried out in the laboratory in an endeavor to obtain the foregoing and noted how close the theory involved agreed with the experimental results obtained.

At a meeting of the Branch on April 4, C. P. Kenville, '17, gave a talk on The Present Tendencies in the Design of Ship Hulls in which he discussed the recent experiments that have been carried out at Washington, D. C., relative to the resistance of ships of various designs. Prof. H. B. Langille, Mem.Am.Soc.M.E. and Professor of Machine Design at the University, spoke along the same lines, his subject being Ship Resistance and Propeller Design. He explained the methods used to calculate the resistance of ships and the present drafting room practice relative to propeller design.

An illustrated lecture on Gold Dredging and Dredger Construction was presented by H. G. Oliver. Mr. Oliver outlined the methods of dredging in California and showed views of the world's largest gold dredger during construction and in operation in the field after its completion.

UNIVERSITY OF COLORADO

At a meeting of the Student Branch of the University of Colorado on March 16 the following officers were elected: Harlow Platts, president; Guy Kurtz, vice-president, and Robert F. Hamilton, secretary and treasurer. Following this Prof. John A. Hunter, Mem.Am.Soc.M.E., and Professor of Mechanical Engineering in the University, spoke on the advantages of an organization such as the A.S.M.E. Student Branch to the school and also to the members of the organization.

At a meeting of the Branch on March 30 Thomas Cleary of the Westinghouse Electric & Manufacturing Co. spoke on the Westinghouse Under-Feed Stoker. After explaining the operation and use of the three kinds of mechanical stokers, the over-fed, the under-fed, and the chain grate, Mr. Cleary took up the Westinghouse stoker in detail, and pointed out that with the mechanical stoker less labor and less fuel are required, and the boiler capacity is increased, this increase in capacity being limited only by the amount of fuel fed in.

UNIVERSITY OF ILLINOIS

At a meeting of the University of Illinois Student Branch on March 23 Miss S. Harbarger of the English department of the University addressed the members on Rhetoric and the Engineer. Miss Harbarger asserted that rhetoric is important to the engineer because it is a means of recreation, of efficiency and of preparedness. Rhetorical work gives confidence in one's ability to create a desirable impression on others and is therefore a necessary tool for the engineer. The speaker pointed out that the attitude of the engineering student toward rhetoric is likely to be his attitude toward his profession and therefore should be a healthful one.

UNIVERSITY OF KANSAS

The University of Kansas Student Branch held its seventh annual meeting on March 9. Professional sessions were held both in the morning and afternoon, and at seven o'clock in the evening a banquet was served at Marvin Hall.

UNIVERSITY OF KENTUCKY

The members of the Student Branch of the University of Kentucky returned from an instructive inspection trip through Chicago, in time to start thesis work on April 4. The regular program of the Branch was suspended and talks by eminent engineers substituted.

On April 5, a comprehensive lecture was given by J. N. Breckenridge on the Manufacture of National Pipe by the National Tube Company. His lecture was illustrated by moving pictures showing the whole process of manufacture from the raw material to the finished pipe.

Willis H. Carrier, Mem.Am.Soc.M.E., and President of the Carrier Engineering Corp. of New York City, visited the Branch on April 10 and presented an illustrated lecture regarding the great variety of problems which the air engineer has to solve.

An interesting talk on The Boiler of 1916 was given by F. C. Bitgood of the Babcock & Wilcox Co. This is a boiler of the water-tube type carrying 350 lb. of steam at a superheat of 250 deg. Mr. Bitgood stated that the present tendency of boiler manufacture was for high pressure with just enough superheat to prevent initial condensation, and that the boiler for 1917 will have a pressure of 500 lb. steam at a superheat of 100 deg. He also said that a boiler with a steam pressure of 1000 lb. is the ultimate desire of his Company and that it will probably be realized in the 1918 boiler.

UNIVERSITY OF MICHIGAN

At a joint meeting of the Student Branch of the A.S.M.E. and of the A.I.E.E. was held on March 31, at which G. W. Lunn of the Commonwealth Edison Co., Chicago, gave an interesting lecture on Central Stations. Mr. Lunn sketched briefly their history and took as an example of the latest developments the three plants of the Edison Co. at Chicago, which he described at length. The site, buildings, prime movers, boilers, electric machinery, auxiliary apparatus, tests, and safety provisions were dealt with, and the welfare work of the company outlined. The lecture was illustrated by slides.

UNIVERSITY OF MINNESOTA

The Student Branch of the University of Minnesota held a meeting on March 25, at which Mr. John Corser, '16, gave an interesting talk on Alaska. Mr. Corser was employed by the Copper River and Northwestern Railroad Company during the construction of their two hundred miles of railroad from Cordova, on the sea coast, to Kennicott, which is located in the rich mining and timber lands of Alaska. He spent 3½ years in this region and is familiar with the commercial conditions there.

Mr. Corser said that the Copper River and Northwestern Railroad is the first railroad ever built in Alaska that has been a success, and in spite of the many difficulties and unexpected problems encountered, it paid for itself during construction. This can be explained by the fact that the passenger fare was 20 cents per mile and the freight rates accordingly high.

Unexpected problems were encountered in the rock cuts along the banks of the Copper River and in the large dirt cuts. The strata formation along the Copper River is such that the layers of rock form an angle sloping toward the river and when a cut was made through the rock the lower part of the cut would gradually slide away and that above would come down upon the roadbed. In some cuts, it was found necessary to remove four times as much rock as had been intended. In the dirt cuts, the ground was frozen to a depth of from 18 in. to 2 ft., and after making a cut the sun would thaw out the ground at the top of the bank and it would slide down in the form of a large mass of mud. This made it necessary to widen all the cuts to a greater width than had been anticipated.

During the winter months the road is closed a great part of the time, and when it is open there is no scheduled running time as the snow often makes it impossible for the trains to make any progress. Snow sheds and rotary snowplows have improved the winter conditions considerably during the last two or three years.

Each spring the Kennicott end of the railroad is closed due to washouts and one of the bridges across the Copper River near Kennicott has been washed out every spring. The greatest flood occurred in the spring of 1913 when large sections of the road were washed away.

The speaker, in closing, compared Alaska with the United States as to size and climate. Although Alaska is only one-fifth as large as the United States, it has a population of nearly 10,000 white people and about five or six times as many natives, mostly Indians. The climate varies along the southern coast; the summers are similar to those of our western coast, but cooler, due to the warm water currents of the Pacific Ocean; the winters are cold, the temperature falling as low as 60 deg. below zero. Further inland, the climate is extremely cold and the summers are very short.

UNIVERSITY OF MISSOURI

A meeting of the Student Branch of the University of Missouri was held on April 6, at which the following new officers were installed: F. P. Hutchison, president; Louis Seutter, corresponding secretary; R. B. Warren, secretary and treasurer; and a governing board consisting of J. W. Haney, Mem.Am.Soc.M.E., R. M. Lotz and F. N. Westcott.

E. J. McCourtland, Dean of the Engineering School of the University, gave an illustrated lecture entitled Sanitary Engineering, dealing with community and personal sanitation.

UNIVERSITY OF NEBRASKA

The Student Branch of the University of Nebraska held a meeting on March 15, at which O. R. Martin, Professor of Business Accounting of the University of Nebraska, presented a detailed definition and description of a corporation and of a partnership, explaining the distinction between the two. He said that a corporation is considered as an individual inasmuch as it is responsible for its actions, as a whole body, but the members, separately, are not responsible. In a partnership, however, each individual is responsible for the firm. When Professor Martin had concluded his remarks on this subject, he gave a brief outline of the different kinds of stocks.

On April 4, Prof. G. E. Barber, who is the head of the Department of Roman History and Literature, gave a talk on Engineering in Ancient Rome. The speaker gave an outline of the materials used in Ancient Rome—natural stones, both chiseled and rough; concrete, brick, and stucco work. He said that the Roman roads were from two to three feet thick and consisted of natural stone cemented and pounded together. Interesting lantern slides of the old temples, theaters, walls and public buildings followed the talk, showing in considerable detail the Roman methods of building.

VIRGINIA POLYTECHNIC INSTITUTE

On April 8, a meeting of the Virginia Polytechnic Institute Student Branch was held at which a paper on Injectors by H. M. Harris and F. C. Holton was presented. The principles of the various types of injectors were discussed and the talk was illustrated by blackboard sketches.

H. A. Coddington, Engineer of Tests of the Norfolk and Western Railway presented a paper at a meeting held on April 12 on Superheated Steam and Superheaters as Applied to Locomotives. The lecture was supplemented by lantern slides, showing the method of construction and installation of superheater units on modern locomotives.

A meeting of the Branch was held on April 15 at which two papers were presented. The first was on the subject of Feed Water Heaters by A. T. M. Rust and A. J. Bopp, who discussed the several types of heaters now on the market and illustrated their talk with black-board sketches. The second paper was presented by G. F. Minor and H. L. Dodson entitled Centrifugal Pumps. Black-board sketches were used to illustrate this paper, and the subject was treated from its historical side as well as from a mechanical standpoint.

WORCESTER POLYTECHNIC INSTITUTE

At a meeting of the Worcester Polytechnic Institute Student Branch, James F. Howe, '99, Mem.Am.Soc.M.E., of the American Steel and Wire Rope Company, addressed the members on Wire Rope and Its Relation to Engineering. The speaker first called attention to the disadvantages possessed by chains, namely, their bulk and low tensile strength, and explained that a rope of one-quarter the cross sectional metal area of the chain would be of equal strength. Cold working of the metal after heat treatment was given as one reason for the great reliability of wire rope material. Mr. Howe stated that flexibility, durability, and efficiency are the three desirable qualities which the manufacturers strive for, and each particular use to which the rope is put requires individual consideration and design. This is necessary because of the fact that the maximum flexibility, durability and efficiency cannot be found in any one case, but one or more of these qualities must suffer at the expense of another. Numerous slides were shown which illustrated the various uses of wire rope as well as the many shapes, styles and sizes of rope and fastenings.

YALE UNIVERSITY

The Yale University Student Branch held a meeting on January 21, at which F. L. Low addressed the students on the Panama-Pacific Exposition. Mr. Low spoke mainly of the lighting effects of the exposition and showed slides which were loaned by the National Electric Light Association.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, and is pleased to receive requests both for positions and for men. Copy for the Bulletin must be in hand before the 18th of the month. The notices now appear in the Employment Bulletin in a form which indicates the classification.

POSITIONS AVAILABLE

The Society acts only as a "clearing house" in these matters and is not responsible where firms do not answer. Stamps should be enclosed for forwarding applications. Those not members of the Society are required to file a letter of reference or introduction from a member before applications will be forwarded.

7 PROFESSOR OF ELECTRICAL ENGINEERING of high grade technical capacity, vigor, personality, experience in practice and teaching ability. A man of high standing among engineers and recognized as an authority. Location Middle West.

40 DESIGNER; good opportunity for high grade designer with chiefly drawing office experience on heavy machine tools and similar machinery. Location, Pennsylvania.

44 DESIGNERS experienced in automobile work. Location New York.

164 DRAFTSMAN, thorough technical training with at least 5 to 6 years practical experience as draftsman and designer of heavy high speed machinery, as steam turbines, centrifugal pumps and herringbone gears. Must be neat, quick and accurate, and possess such characteristics as would justify promotion to chief or assistant chief engineer in one to two years time. Salary to begin moderate until ability is proven. Location Maryland.

167 RECENT GRADUATES in mechanical engineering from schools of recognized standing, desired for testing work in large steam operated electric power plants. Applicants with experience in testing work will be given preference. State particulars of education, experience and salary desired. Location New York.

180 INSPECTOR, for interchangeable parts on fine balances. Young man with tool making experience preferred. Eastern location.

185 TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Location Connecticut.

187 DRAFTSMAN with blast furnace and rolling mill experience. Location Pennsylvania.

188 DRAFTSMAN with at least ten years drafting office experience, competent to take charge of a number of men and capable of doing his own calculating. Location Pennsylvania.

192 SUPERINTENDENT to take charge of foundry and scrap reclaiming department, handling all kinds of non-ferrous metals, employing 250 men; must be good executive with business ability and sound knowledge of metallurgy of non-ferrous metals; give full details of experience and qualifications. Location Western Pennsylvania.

193 TOOL DESIGNER accustomed to heavy machine tool work, for manufacturers of milling machines and their equipment. Location, Illinois.

197 CHIEF INSPECTOR for large valve and gage manufacturing concern; plant employs about 1500 men and women; requires man of wide experience of at least ten years, in interchangeable manufacturing field. Location, New England.

198 CHIEF INSPECTOR, up-to-date, well versed in drill press practice in fine interchangeable work, with at least 10 years experience.

201 VALVE AND FITTING DESIGNER and checker with large firm; good future to man with experience who is willing to hustle and work hard. Others need not apply. State experience in full, salary expected and references. All correspondence will be strictly confidential.

202 INSPECTOR OF MATERIAL AND SUPPLIES to work under the supervision of the head of bureau of tests of New York concern manufacturing paper products, to accumulate data which will form basis for research work leading to standardization of grades of paper and other materials used in manufacturing processes. One or two years experience in paper industry would be especially helpful.

203 ASSISTANT TO SUPERINTENDENT OF EMPLOYMENT; young university graduate to develop a systematic plan for engaging, training and recording progress of employees; one who has made a study of psychology or at least with clear conception of the requirements of such a position. Location New York.

205 SALES ENGINEERS. It is desired that applicants be young men between the ages of 25 and 30 years, graduates of some approved engineering college, preferably M.E. degree and of good appearance; would be expected to undergo a period of probation and training in the various offices of company before being given more responsible and higher positions in sales work. If a call cannot be made, application may be made by letter in the applicant's own hand writing, stating age, education, previous business training if any, salary desired, etc. Location, New York.

212 SALES ENGINEERS for the following territories: Central Pennsylvania, New Jersey, New England, Tennessee, North Carolina, Minnesota, North and South Dakota; must show excellent past record and be familiar with boiler plant practice; must be men of good personality. Apply by letter.

213 DESIGNER—experienced in design of machine tools; resourceful and capable of doing original work. Salary dependent upon man.

214 SUPERINTENDENT OF SHOP, to have charge of shop covering repair work, erection of machinery, general repairs on buildings and furnaces, millwrighting, etc., employing about 150 men. Name confidential. Location, Eastern States.

216 DRAFTING ROOM SUPERINTENDENT. Good position open in large flour milling machinery factory. Preferred qualifications; technical, mechanical education, executive capacity, experience in mechanical transmission machinery layouts, the producing of flour and cereal milling machinery and machinery installation plans. Permanent position for right man. Give full particulars of experience, also salary expected.

217 ENGINEER to take charge of manufacturing operations of work in machining in iron and brass, copper, smithing, etc., necessitating working closely to dimensions. Prefer technically trained man. Essential qualifications are knowledge of the trade, shop organization, cost keeping, etc., with personality to control men. Salary about $2500. Location, New York.

218 ENGINEER to take charge of drafting room; output consists of coal handling apparatus, hoisting engines, special heavy machinery and tools, locomotive and overhead cranes. Salary $150 per month, with good prospects of a permanent position and advancement to right man; technical graduate preferred. Give age, reference, and state where last employed. All replies will be held strictly confidential.

219 RECENT GRADUATE with some experience in making boiler tests, to train into work of inspection of boiler plants and steam engine installations in connection with refrigerating and ice making machinery. Location East. Apply by letter. Name confidential.

220 INSTRUCTOR IN MECHANICAL ENGINEERING. Salary $1000 to $1200. Location Middle West.

222 EXECUTIVE SUPERINTENDENT for elevator repair and supply company. Location New Jersey.

224 ENGINEER experienced in testing and installation of steam turbines and turbine driven apparatus. Must be capable of intelligently running and witnessing tests on apparatus, both in buying and selling and handling general engineering details. In application give experience, salary expected, etc.

230 WORKS MANAGER wanted at once; thoroughly trained and experienced mechanical engineer as manager of large shop having many departments (principally machine) and making a complicated product of small parts. Only applications from those who have had successful experience in handling such a proposition will be considered. Give full particulars including age, nationality, where and in what lines experience was gained and approximate salary expected. Name strictly confidential. Apply by letter.

231 DETAIL DRAFTSMAN on structural and mechanical work. State experience and salary expected. Location Kansas.

232 AGENTS to handle sales of products in own territory, for firm specializing in manufacture of crushers, adapted for road building, contracting, mining, rock crushing, for pulverizers, gravel plants, block and tile plants.

237 ENGINEER experienced in time study work on machine operations. Salary depends on man. Location New Jersey. Apply by letter.

238 MECHANICAL ENGINEER to take charge of research department in the development and manufacture of underfeed mechanical stokers. Must have had experience in designing, construction and operation. Good opportunity for the right man with old established corporation. State age, experience, when at liberty, salary expected, etc. Apply by letter.

240 ASSISTANT to general power plant engineer; work would cover power design, construction, testing, etc., in large industrial plant. Salary $900. Location, New Jersey.

243 EFFICIENCY ENGINEER; American under 30, technical graduate preferred with practical experience. Will for several years act as understudy for ultimate position of efficiency engineer. Salary to start $100 per month. Send postal card with name and address for further particulars.

244 MECHANICAL AND ELECTRICAL ENGINEER to handle the various engineering problems of power generation, distribution and installation of new equipment, maintenance, etc., exclusive of operation of plant; preference given to man not over forty, but ability and experience in industrial plant work must be unquestioned. Name confidential.

245 MANAGER of Advertising Department for concern in Middle West, manufacturing line of boiler specialties.

246 SUPERINTENDENT of factory engaged in the manufacture of oil and gasoline engines. Must be familiar with modern methods of manufacture, active, tactful, a close student of human nature and a natural leader. Exceptional manufacturing men even though not actively engaged in gas engine work are encouraged to reply. Position offers a splendid opportunity for one who can qualify. Give complete experience. Name confidential. Apply by letter.

248 DESIGNER for special machinery and labor-saving devices capable of following work through shop to completion. Location, New York State.

250 MANAGER for firm in India manufacturing clay products, as drainage pipes, tile floors, bricks and wall tile. Correspondence will be handled through New York firm.

252 PRODUCTION SUPERINTENDENT, as assistant superintendent in charge of production, in a high class engine and machinery building plant; preferably a man who has had experience in planning and carrying on production according to sales and stock requirements. State qualifications and salary expected. Applications will be treated in strict confidence.

253 GRADUATE TECHNICAL MECHANICAL ENGINEER, as assistant to factory executive; young, energetic man. State age, education, past positions, if any, and salary expected at start.

255 DRAFTSMAN, American or English, familiar with tool design. Location, Philadelphia.

256 TECHNICALLY TRAINED MECHANICAL ENGINEER who has had several years' experience in shop methods and costs, wanted, to increase the applications of a new metal working process. Exceptional opportunity for right man. State salary, experience and references.

258 WORKS MANAGER for company manufacturing heavy chemicals; position is one of responsibility and demands high order of executive ability; one educated as a chemical engineer or chemist who has demonstrated executive ability. Location Western Pennsylvania.

259 SPECIAL AGENT FOR SOUTH AMERICAN MARKETS for construction materials and machinery. Examination in May (date not yet assigned) to be held under the direction of the Department of Commerce. Application to take the examination should be made direct to the Bureau of Foreign and Domestic Commerce, Washington, D. C., and should set forth applicant's education and experience in the subject of the investigation.

MEN AVAILABLE

Only members of the Society are listed in the published notices. Notices are not repeated in consecutive issues of the Bulletin.

Members sending in notices for the Men Available section are particularly requested in the future to indicate the classification under which they desire their notices to appear.

E-161 ENGINEER on large steam turbine, power plant installation, operation and efficiency investigations; 10 years experience in charge.

E-162 SALES ENGINEER among building trades, preferably in New York. Acquainted with leading architects and engineers throughout East and Middle West. Six years successful experience as engineer and salesman for prominent New York manufacturing concern and at present holding responsible position.

E-163 ASSISTANT TO PRESIDENT, MANAGER OR SUPERINTENDENT: Member, 39, M. E. 18 years experience in design and manufacture of steam and hydraulic machinery; twelve years in design, construction and operation of large industrial plants successively as assistant superintendent, superintendent and general superintendent; expert in organizing, cost, statistical and production work. Present position general superintendent of large manufacturing plant; salary $6000 per year.

E-164 MECHANICAL ENGINEER at present chief draftsman of large manufacturing concern, desires change. 20 years experience general engineering, automatic labor saving machinery, resourceful, hustler; looking for opportunity to advance. Salary $3000 to start.

E-165 EXPERT on power plant work and equipment with valuable patents in that line; strong personality, excellent executive and salesman desires to invest several thousand dollars in established engineering enterprise or to form partnership with consulting engineer. Advertiser is also ready to act as consulting engineer to engineering concerns.

E-166 MECHANICAL ENGINEER with manufacturing plant, central station or consulting engineer; member, 34, married, technical education, experienced in design, erection and efficient operation of power plants, as principal assistant to consulting engineer; specialized in up-to-date boiler room management and efficiency use of exhaust steam. Eastern states preferred.

E-167 COLUMBIA GRADUATE in mechanical engineering, with drafting room, power plant and shop experience, seeks position offering opportunity for advancement. At present employed as assistant foreman inspector in large arms plant.

E-168 VACATION POSITION, June-September, desired by instructor in mechanical drawing in large eastern university; six years practical experience in estimating and designing machinery.

E-169 METALLURGICAL and MECHANICAL ENGINEER; member, age 34, married, specialist in the design and construction of mining, crushing, milling, smelting and acid plants. Ex-

pert on oil-flotation concentration, fine grinding, blast furnace and reverberatory furnace smelting. Thirteen years with mining, milling and smelting companies and manufacturers, wishes responsible executive or engineering position in which broad engineering experience together with ability to handle men will be required. Now in South America, but will go any place. Wire "The Journal" for letter giving complete experience and references.

E-170 MANAGER, SUPERINTENDENT or SALES ENGINEER. Member, graduate M. E., Lehigh University, several years in management of mechanical and purchasing departments of railroad, coal mining, and industrial corporations; extensive experience as sales engineer in railroad equipment. Organizer and executive, qualified to fill position of manager of an industrial plant or coal mining company, or superintendent of motive power of a railroad. Can successfully represent manufacturers of machinery, power plant equipment, iron and steel.

E-171 MACHINE SHOP SUPERINTENDENT or MASTER MECHANIC with wide range of experience in large steel plants, thirty-two; technical graduate, desires to make change of position with future; best of recommendations; interview is preferred.

E-172 SALES ENGINEER, age 33, technical graduate, member, seven years sales experience machinery and steel. At present employed. Wishes better opportunity for advancement with high class firm.

E-173 ASSISTANT WORKS MANAGER, mechanical engineer or similar capacity, automobile industry preferred. Junior member, age 31, married, technical graduate, experienced in power plants, testing and investigations, general mill engineering.

E-174 TECHNICAL GRADUATE, experienced in general power station design, also engineering and construction, administrative and sales departments of manufacturing corporations, desires connection with manufacturing company with eventual investment of capital; member, age 37, married, eleven years practical experience in U. S. and abroad.

E-175 CHIEF ENGINEER, POWER ENGINEER or PLANT ENGINEER, graduate mechanical and electrical engineer, age 33; 13 years extensive experience in designing, constructing, erecting and testing power plants, sub-stations, etc., desires to lolate with large firm where conscientious ability will be appreciated. Salary $2500. At present holding responsible position. Location Eastern States.

E-176 STUDENT MEMBER, will graduate this June, desires a position with an engineering firm promising an opportunity for advancement.

E-177 STUDENT MEMBER, five years experience as a machinist before entering university, desires a position with consulting engineers, or in efficiency work with manufacturing firm. Will graduate in June.

E-178 PLANT ENGINEER, member, Cornell graduate with eleven years experience in design, construction, maintenance and operation of industrial and power equipment for three of the largest concerns in this country, desires to make a change. An efficient executive who obtains results. Salary $3600.

E-179 STUDENT MEMBER, graduating from course in mechanical engineering at Worcester Polytechnic Institute in June, wishes position with manufacturer of automobiles, or manufacturer of marine or automobile motors. No drafting. References if desired.

E-180 MECHANICAL ENGINEER or MASTER MECHANIC, age 31, graduate M. I. T., five and one-half years experience in design, construction and maintenance of power plants for textile mills; experienced as master mechanic of textile mills; can handle men and get results. At present employed; desires advancement.

E-181 SUPERINTENDENT, technical graduate, broad experience in general manufacturing in lines usually associated with an establishment whose output is of specialties and general engineering products. Tactful, resourceful and energetic. At present employed. Desires executive position which would be an advancement.

E-182 SALES ENGINEER or MANAGER; graduate engineer with sound practical experience and thoroughly acquainted with the best business practice.

E-183 SALES ENGINEER, MANAGER or MANUFACTURERS' REPRESENTATIVE. Worcester Polytechnic Institute graduate in mechanical engineering, age 36. Thirteen years broad practical experience selling and managing sales or pumping machinery, air compressors and internal combustion engines with their auxiliary equipment, in New York City. Good business record with leading concerns in these lines and is now available.

E-184 SALES ENGINEER, MANAGER or SUPERINTENDENT with technical education and 16 years splendid engineering experience. Six years as draftsman, estimator and chief draftsman, five years chief mechanical engineer large shops manufacturing special machinery, and last five years sales-engineer large power plant contractors. Available on short notice.

E-185 EXPERIMENTAL ENGINEER or ASSISTANT TO EXECUTIVE. Junior Member, Stevens 1911 Graduate, age 28 years, varied experience in power plant, field and office. Last three years in successful executive and experimental work. Possesses initiative, good personality, unusual mathematical ability. At present employed in Pennsylvania. Desires to locate with concern where ability and energy will win advancement.

E-186 ASSISTANT TO ENGINEER or INSTRUCTOR IN MECHANICAL ENGINEERING, would like permanent position as test engineer, assistant to consulting or mechanical engineer or instructor in mechanical engineering. Junior Member, college graduate, age 25, practical experience in drafting, testing and design in steam, hydraulic, electrical and gas engineering; also experience on appraisal work and teaching.

E-187 SALES ENGINEER, M. I. T. graduate, age 29, Associate Member, with three years shop and designing and five years sales engineering experience on pumping machinery and power plant equipment, desires position as sales engineer in New England with headquarters in Boston. Capable salesman with ability to develop business, also careful engineer. Would consider a New England agency.

E-188 ENGINE SPECIALIST in stationary gasolene, kerosene and high speed engine design. Age 27, seven years experience in design, lay-out, jigs and tools, foundry equipment and general shop superintendence.

E-189 EFFICIENCY ENGINEER. Cornell, M.E., age 33, understands human nature, capable of handling men diplomatically and to advantage. Experience gained in over twenty different organizations of a very large concern, desires position where traveling is not required, or will consider position as head of employment department.

E-190 FACTORY MANAGER, WORKS OFFICE MANAGER or ASSISTANT to executive of large organization. Member, age 34, experienced in the manufacture and design of water tube boilers and general plate work. At present employed.

E-191 PUBLICITY ADVERTISING MANAGER or similar position of responsibility desired by Associate Member with over seven years experience in technical publicity work (advertising, catalogs, editorial, engineering papers and articles). Experience mainly in power plant and general machinery fields. Graduate M.E., age 34, married. At present employed.

E-192 MECHANICAL ENGINEER, teaching or commercial position; technical graduate, age 33, four years practical experience as designer and as experimental engineer; five years experience in teaching mechanical engineering subjects including a large amount of experimental work. At present employed. Can furnish best reasons for desiring to change.

E-193 EFFICIENCY, PLANT or SALES ENGINEER: Associate member, graduate mechanical engineer, 32, married. Practical shop man with American and British experience; design and construction of buildings, also structural and mechanical equipment of hydro-electric plants, sugar factories, conveying and elevating machinery, foundry and machine shops.

E-194 ENGINEER ON OIL ENGINES, desires position as executive, chief engineer, manufacturing superintendent, engineer of tests, or assistant with a concern producing or intend-

ing to take up the manufacture of oil engines. Member, University training with extensive experience in the design and construction of marine and stationary four and two-cycle Diesel engines; has held position with a leading German firm as co-worker in the development of the marine commercial type.

E-195 WORKS ENGINEER OR ASSISTANT SUPERINTENDENT; Member, graduate in mechanical engineering, age 35, married; drafting room, erecting, installing, testing and industrial plant design experience, and some sales experience; two and one-half years in executive capacity operating plant costing $300,000. Immediately available.

E-196 MANAGER OR SUPERINTENDENT of office building or apartment house or head of service and maintenance department of manufacturing concern or industrial plant. Associate Member, technical graduate, age 30. At present mechanical assistant to manager of large office building. Previous industrial plant experience.

E-197 MATERIALS TESTING LABORATORY ENGINEER; wishes to install and operate laboratory for manufacturing or experimental plant and to push commercially some specialty with a future. Experience includes five years as machinist; technical graduate; executive and production work in U. S., Germany and England; charge of materials testing laboratory for one of leading universities in this country and for the U. S. Government; thorough teaching experience in mechanics and the strength of materials. American, unmarried, age 39.

E-198 FACTORY MANAGER OR GENERAL SUPERINTENDENT. Location must be with a live progressive growing concern, or with a concern that recognizes need of improvement and requires a man who has years of experience with large manufacturing companies and is capable of dictating policies that will bring satisfactory results. Leaving responsible position for larger field. Open for engagement May or June.

E-199 PRODUCTION ENGINEER and AUTOMOBILE DESIGNER; Member, desires position as purchasing or shop engineer; sixteen years experience in U. S. A. and in France; can offer exceptional references.

E-200 STUDENT MEMBER, practical experience in machine shop one year, desires opportunity with some manufacturing concerns. Graduate in mechanical engineering in June, can furnish excellent references.

E-201 STUDENT MEMBER; M.I.T., 1917; desires position during Summer from middle of June until September.

E-202 STUDENT MEMBER, will graduate in June in the Mechanical Engineering course, Bucknell University; three years practical experience in general repair shops, desires a position with chances for advancement. Age 24; can give references and recommendations.

E-203 STUDENT MEMBER, expecting to graduate in June, desires a position. One year electrical work before entering college; nine years experience working at driving and overhauling automobiles during vacations.

E-204 STUDENT MEMBER will graduate in June in mechanical and electrical engineering, desires employment in the South in utility, oil or phosphate work. Will go to Central or South America.

E-205 STUDENT MEMBER, technical graduate, one year's experience in costs, stores and efficiency, wishes to make a change at once.

E-206 SUPERINTENDENT OR ASSISTANT SUPERINTENDENT of a large concern employing approximately 1500 men and girls and engaged in the manufacture of war munitions as a side line, wishes to connect with some large concern in a similar capacity. Twenty years experience in interchangeable work. Prefer a commercial proposition to munition work. Technical education. Present salary $3000.

E-207 ASSISTANT MANAGER OR CHIEF ENGINEER. Fifteen years experience in design and manufacture of pumping and hydraulic machinery. For many years connected with large concern as head of the engineering department; thoroughly familiar with production methods, shop organization, routing of material, and accounting system. Connection with smaller concern preferred, specially centrifugal volute and turbine pumps.

ACCESSIONS TO THE LIBRARY

A List of Books and Pamphlets Added During the Past Month to the Library of the Society and of the United Engineering Society, Engineering Societies Building, New York

ADDITIONS BY THE SOCIETY

AFFIDAVIT OF SAMUEL S. WYER, CONSULTING ENGINEER, ON PRESENT SITUATION OF THE KANSAS NATURAL GAS COMPANY. In the District Court of the United States. No. 136-N. John M. Landon and R. S. Litchfield vs. The Public Utilities Commission of the State of Kansas. Gift of S. S. Wyer.

AIR IN COMPRESSION AND EXPANSION, Chart. C. K. Bennett. *1916.* Gift of author. Price $1.00.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Journal vol. 37. (2 vol.) *New York, 1915.*

BRAKE PERFORMANCE OF MODERN STEAM RAILROAD PASSENGER TRAINS; a discussion of the Pennsylvania Railroad Brake Tests, 1913, S. W. Dudley. *Pittsburgh, 1914.* Gift of A. S. M. E.

CAISSON AS A NEW ELEMENT IN CONCRETE DAM CONSTRUCTION A PROPOSAL MADE IN CONNECTION WITH THE COLUMBIA RIVER POWER PROJECT, O. G. Aichel. *New York-London, 1916.* Gift of author.

ELECTRIC AUTOMOBILE CHARGING STATIONS IN NEW YORK CITY AND VICINITY, with route maps, 1916. *New York, 1916.* Gift of New York Electric Vehicle Association.

ELECTRICAL RAILWAYS, H. M. Hobart, being the "James Forrest" lecture, 1915, delivered at Institution of Civil Engineers. *London, 1915.* Gift of James Forrest.

ENGINEERING THERMODYNAMICS. By J. A. Moyer and J. P. Calderwood. *New York, 1915.* Gift of J. Wiley & Sons. Price $2.00.

This is written to fill the need for a brief and concise text book to be used in technical schools. The authors consider the other text books in use to have too much duplication of subject matter.

W. P. C.

EXPERIMENTS ON THE RATE OF HEAT TRANSFER FROM A HOT GAS TO A COOLER METALLIC SURFACE. *New York, Babcock & Wilcox Company, 1916.* Gift of Babcock & Wilcox Company.

GENERAL SOCIETY OF MECHANICS AND TRADESMEN OF THE CITY OF NEW YORK. Annual Report, 1915. *New York, 1916.* Historical Sketch and Government, 1785-1914. Gift of General Society of Mechanics and Tradesmen.

NEW YORK CITY, BOARD OF WATER SUPPLY. Contract 120, information for bidders, forms of proposal, contract, etc. for construction of two superstructures for the Hudson and Croton Lake Drainage chambers in the towns of Fishkill, Dutchess county, and Yorktown, Westchester county, N. Y. *1916.* Gift of Board of Water Supply.

SPERRY GYRO STABILIZER FOR SHIPS. Gift of Sperry Gyroscope Co.

SPRINGFIELD, MASS. WATER COMMISSIONERS, 42. Annual Report, 1915. *Springfield, 1916.* Gift of Springfield Water Commissioners.

FREDERICK W. TAYLOR, REVOLUTIONIST, Frank B. Copley. Privately printed, 1916. Gift of Frederick W. Taylor Co-operators.

U. S. LIGHTHOUSE SERVICE, DEPT. OF COMMERCE. General information, 1915. *Washington, 1916.* Gift of U. S. Department of Commerce.

USE AND ABUSE OF COAL SPECIFICATIONS. *New York, 1916.* Gift of Fuel Engineering Company.

WEB OF STEEL. Cyrus Townsend Brady. Father and Son. *New York, Fleming H. Revell Company, 1916.* Gift of Publisher.

GIFT OF WASHINGTON SOCIETY OF ENGINEERS

ESTRADA DE FERRO CENTRAL DO BRAZIL. Noticia sobre a Duplicacão da Linha na Serra do Mar. *Rio de Janeiro, 1914.*

AVENIDA CENTRAL. 8 de Marco de 1903. 15 de Novembro de 1906. (Portfolio of views.)

MENSAGEM OFFERECIDA AO EXMO SNR. Dr. André Gustavo Paulo de Frontin. *Sept. 1912.*

SESSAO MAGNA DO CONSELHO DIRECTOR NO DIA 24 DE DEZEMBRO DE 1914, 34° ANNVERSARIO DA FUNDACAO DO CLUB DE ENGENHARIA. *Rio de Janeiro, 1915.*

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[1] A complete list of the officers and committees of the Society will be found in the Year Book for 1916, and in the February 1916 issue of The Journal.

ENGINEERING SURVEY

A Review of Engineering Publications in All Languages. All the leading periodicals of the engineering world, embracing over 1000 different publications, are received at the Library. These are systematically examined for review each month in the Survey.

SUBJECTS OF ABSTRACTS

ARRANGED IN THE ORDER OF THEIR APPEARANCE IN THE SURVEY.

EXPERIMENTAL FAN IN THE LABORATORY.
FLOW OF AIR THROUGH NOZZLES.
HEAT TREATMENT AND PHYSICAL PROPERTIES OF STEEL.
THICKNESS AND TENSILE STRENGTH OF STEEL PLATES.
MARKINGS OF SAWINGS ON METAL BARS.
POWDERED COAL IN OPEN-HEARTH FURNACE.
OPEN-HEARTH FURNACE WITHOUT REGENERATION.
POWDERED COAL BURNERS.
POWDERED COAL DRYING.
SURFACE COMBUSTION FURNACE. TESTS.
HOT-BLAST MAINS, LOSSES.
LEAD JOINTS, LEAKAGE.
VALVES IN WATER WORKS.
SOLID-WEDGE VALVES.
DOUBLE-DISC VALVES.
KLINE ROTARY VALVE.
FREDERICKSON TWO-CYCLE ENGINE.
BROWN-BOVERI GAS TURBINE.
DETROIT GAS TURBINE.
LIQUID-FUEL ENGINE EXHAUST.
LUBRICATION TESTS, PLOTTING.
SPRING SUSPENSION, AUTOMOBILE.
CHISELS.
DYNAMOMETER FOR TRACTORS.
FREIGHT BRAKE, EMPTY AND LOAD.
STEAM TURBINE BLADE FASTENING.
LOVEKIN BLADE FASTENING.
BLADE FASTENING ON U. S. S. "NEVADA."
OIL COOLER ON U. S. S. "NEVADA."

Notices from German publications have reached the Library to the effect that the German Government has, for military reasons, prohibited the exportation of certain classes of technical literature.

THIS MONTH'S ARTICLES

Data on the use of experimental fans in a mining laboratory, together with the results of some tests on the determination of the coefficient of the *vena contracta*, are presented in an article abstracted from the *Transactions of the Institution of Mining Engineers*. An abstract of Thomas B. Morley's paper on the flow of air through nozzles, read before the Institution of Mechanical Engineers, is given in this issue. The abstract of the very interesting discussion which followed the reading of this paper will be given in an early issue of The Journal.

From the German paper *Ferrum* is abstracted a paper on tests concerning the influence of heat treatment on certain physical properties of steam. While the tests have failed to obtain any strikingly new results, they are valuable in confirming certain theories not sufficiently proved previously. An interesting series of tests on the influence of thickness on the tensile strength of steel plates have been made by G. B. Waterhouse. Particular attention is called to the results obtained with Bessemer steel plates.

An installation using powdered coal in the open hearth furnace is described on the basis of a paper read by C. J. Gadd before The Franklin Institute of Philadelphia. It describes an open hearth furnace from which the regenerative principle has been entirely eliminated, while it does not yet appear that the apparatus has been sufficiently developed. The present installation, both because of its size and ingenuity of design, certainly merits attention.

E. Schramm and J. R. Cain present data of some tests made on a surface combustion furnace, giving the highest temperatures reached and a curve showing the ideal conditions of perfect combustion without any excess of oxygen. Of practical interest are the facts shown by the test that first, a temperature of about 3000 deg. fahr. was reached in a little over half an hour with a gas consumption of 3 cu. ft. per minute, and second, that the rate of cooling of the furnace is very slow.

In a series of tests on hot blast mains at the plant of the Bethlehem Steel Company, R. J. Wysor determined the average thermal loss due to cooling water from each hot blast valve, and arrived at certain conclusions of general interest with respect to loss of heat in hot blast mains. Among other things, he believes that insufficient insulation in the hot blast main is a cause of serious temperature and heat losses.

The question of leakage from lead joints in cast iron water pipes in city mains is discussed on the basis of some tests by Arthur H. Smith. In these tests a leakage of 1.58 gal. per day per linear foot of lead joint has been found, and the author believes that as long as pipe lines are built in the present manner leakage must be reckoned with, and further, that if leakage of new work can be limited to one gallon per day per foot of joint under 100 lb. pressure, the performance can be called good and acceptable.

Two articles of a somewhat controversial nature on valves for use in water works are abstracted from *The Journal of the New England Water Works Association*. One champions the use of the solid wedge type because of the experience had with it by the Boston Water Department. Another presents reasons in favor of the double disc type of valve.

In the section internal combustion engineering, besides a description of a new rotary valve and a two stroke cycle aeronautical engine, attention is called to two abstracts on gas turbines. One of these is the Detroit gas turbine, of which, however, no mention of any tests can be found.

The composition of the exhaust from liquid fuel engines is discussed in a paper by Robert W. Fenning before the Institution of Mechanical Engineers. The author introduces the use of exhaust gas charts, which may prove of advantage in engine testing.

Prof. G. B. Upton presents a system for plotting and cross-fairing results in lubrication testing.

The discussion of the metal used for chisels and standardization of their shapes forms the subject of a paper before the Institution of Mechanical Engineers.

A dynamometer for determining the horse power of tractors is described and a chart reproduced.

The empty and load train brake is described, and some data on the comparative efficiency of this type of equipment are given from a paper before the St. Louis Railway Club.

Vickers-Ferranti, Brown-Boveri and Lovekin methods of turbine blade fastenings are compared.

Air Engineering

THE VALUE OF THE EXPERIMENTAL FAN IN THE MINING LABORATORY, David E. Thomas

The object of the paper is to call attention to the value of the experimental fan installation in a mining laboratory, and in general to indicate the nature of the work which can be successfully carried out in mining schools and the possible economic value of this work in mining engineering.

In setting up a mine fan for purely experimental work it is obvious that a reproduction of the conditions of the actual mine is practically impossible, but the construction of lengthy ducts may be obviated by using an orifice in a thin plate to represent the resistances of the mine.

The installation described (Gamble Institute, St. Helens Mining School) consists of a Keith single inlet type fan with a runner 12½ in. in diameter driven by a continuous-current 220 volt motor on the same shaft, with a regulator giving a speed variation from 870 to 1600 r.p.m. The article fully describes the particulars of the installation and methods of obtaining the various quantities such as quantity of air passing, maximum static water gage, etc., and indicates some of the results obtained with the experimental fan. The data presented in the paper show the value of the experimental fan. Among other things, the determination of the coefficient of the *vena contracta* shows the importance of the Murgue and Rateau formulae, particularly in their application to finding the value of the area of a regulator in the mine.

The value of the coefficient of the *vena contracta* is much higher than the generally accepted value 0.65. It may be possible that this value is a little higher than would be obtained in the ordinary mine, owing to the comparatively high velocity of the air in the fan duct of the experimental fan; still, there is no evidence in the experiments on this fan which confirm such a conclusion, and the writer is of the opinion that the value of the coefficient would be more correctly expressed by the value 0.70. The general acceptance of this value would, besides simplifying calculations, result in a closer agreement between the formulae of Murgue and Rateau. The discrepancy already noted between the theoretical deductions and the practical results recorded in the experiments on the water gage obtained with varying inlets, the fan speed remaining constant, is worthy of closer investigation. (*Transactions of the Institution of Mining Engineers,* vol. 50, part 3, February 1916, p. 482, 18 pp., 3 figs. *d.*)

THE FLOW OF AIR THROUGH NOZZLES, Captain Thomas B. Morley

The paper describes experiments the primary object of which was to compare various forms of nozzles with regard to their effectiveness for the production of jets of air having as high a mean velocity as possible. These data made possible a comparison of the discharge and the velocity attained with those calculated from the ordinary theory in which reversible adiabatic expansion is assumed. This investigation was further extended to cover the nature of the impact produced by a jet upon a flat plate, and its relationship to the reaction of the jet. The article describes in detail the nozzles tested. There were six of them. The features the influence of which was investigated were the entrance curves, the rate of divergence after the throat, and the length. The following measurements are described in detail: Measurement of discharge and discharge coefficient, measurement of velocity, the impact apparatus, reaction apparatus, the calculation of velocity, and accuracy of impact reaction and velocity results.

It has been found that nozzles with a larger inlet curve give a higher velocity. Nozzles with a rapid taper are much less effective than those in which the taper is gradual. In the case of some of the nozzles good results were obtained with a length of 1.2 and 0.6 in. respectively, but experiments show that the best results are obtained when the nozzles are even shorter than these lengths; also the comparative efficiency of the nozzles over a very considerable range of pressure seems to be independent of the pressure. Considering the absolute values of the velocities obtained with the best nozzle forms, it has been found that those based upon the reactions are practically equal to the theoretical values, while the impact experiments lead to figures some 12 per cent higher. The efficiency of the best nozzle forms is practically unity. The author comes to the following conclusions as to the flow of air through nozzles and orifices.

In the flow of air through an orifice, it is evident that a *vena contracta* exists, the size of which depends upon the pressure of the air supply, so that the discharge coefficient is variable, increasing as the pressure increases.

A convergent nozzle with a rounded inlet may have a discharge coefficient of 0.98 if it is short; and, so long as there is no sharp change of curvature, alterations in the form of the entrance curve have very little effect upon the coefficient. The addition of a divergent part after the throat slightly reduces the coefficient unless the taper is very gradual.

The efficiency of nozzles and orifices, as measured by the mean velocity of the jet produced, is very high indeed, becoming practically unity if they are of the proper form. For pressures up to 50 lb. per square inch, orifices and convergent nozzles are practically equally good. It may be remarked that Rosenhain found that in the case of steam up to 80 lb. per square inch an orifice was better than a nozzle.

While the addition of a short and very gradually divergent part to a nozzle may slightly improve its efficiency, it appears that in general, and within the pressure limits of the experiments, a divergent part added to an air-nozzle is not an advantage, and if such a part has more than a gradual taper, it reduces the efficiency of the nozzle very seriously.

The effect of extra length is not so deleterious as that of a rapid rate of divergence. In the case of divergent nozzles, an entrance curve of about 0.5 in. radius gives an appreciably higher efficiency than one of 0.1 in. radius.

As regards the impact and reaction of jets the author believes that there are two points that call for explanation, when the reactions of the air jets with the forces recorded on a flat plate placed normally to the jets are compared, namely, the variation of the impact with the position of the plate and the relationship between the true momentum per second of the jet and the reaction and impact results.

The paper describes the methods of carrying on the tests and to a certain extent the theory of the impact and reaction action of the jets. The tests showed the expansion of the air is complete at or extremely near to the exit from the nozzle and that while the impact changes considerably between points at distances varying from 2 to 14 in. from the nozzle, the pressure between these points remains nearly constant. The variation of the impact is not therefore due to changes of pressure with corresponding velocity changes in the free jet.

Further experiments carried out by displacing the pressure tube from the axis showed that the smallest perceptible effect on the water gage was indicated at a radius of 0.75 in. at 1.5 in. from the nozzle, and this radius increases in accordance with an approximately parabolic law up to 2.5 in. at 20 in. from the nozzle. These observations, though rough, are in

tolerable agreement with the conclusions of Parenty and others that the jet is a paraboloid in form. Further experiments with a Pitot tube placed in the axis of the jet at various distances from the nozzle have confirmed this conclusion, that the jet is paraboloidal in form and have indicated that the cross-section of the jet is about proportional to the distance along the axis. It is worthy of notice that when the Pitot tube was just at the exit from the nozzle the pressure recorded by the gage to which it was connected was equal to that in the reservoir. This confirms the conclusion previously reached that the efficiency of the nozzle is practically unity.

The parabolic form of the jet has a bearing upon an hypothesis propounded by the author. He believes that an "energy system" of circulating air is set up round about the jet, the external air flowing in nearly normally to the jet until it comes near the boundary of the jet, when it is rapidly accelerated, and, flowing along with the jet, is deflected with it at the impact plate. The remainder of the path of the circulating air is completed in the atmosphere. The "energy system" derives the energy required to initiate it during the establishment of the jet when the flow is first started, but once set up it makes a very small energy demand upon the jet. Hence the induced air derives but little of its momentum at the expense of the original jet with the result that the momentum of the total air deflected by the impact plate is augmented.

While a complete mathematical expression for the system of stream lines set up together with the effect of frictional losses and the consequent effect of the impact plate seems to be impossible, the author gives an expression for the total added momentum per second at any point neglecting friction, as follows:

$$M' = \int -Kx^{-\frac{3}{2}}dx = C - \frac{D}{\sqrt{x}}$$

Where x represents the distance measured along the axis outwards from the nozzle and k a coefficient. M' increases as x increases but its rate of increase, while remaining positive, decreases. On the above hypothesis the observed impact should approach the value M of the true impact of the original jet (the momentum per second of the jet as it leaves the nozzle) as x decreases. As there seems to be no reason why the reaction of the jet should not represent the true value of M, this means that as the plate opproaches the nozzle, the impact should approach the value of the reaction. Among other things, the writer calls attention to the fact that in view of the high efficiency with which the expansion of air in nozzles may be carried out, and the advantages in many circumstances of the turbine over the reciprocating motor, there appears to be a field in which, where power is transmitted by compressed air, the reciprocating motor might with advantage be replaced by an air turbine. (*Journal of the Institution of Mechanical Engineers*, Nos. 2, 3, February and March 1916, pp. 51 and 93, 70 pp., 32 figs. *etA.*)

Engineering Materials

Influence of Heat Treatment on Certain Physical Properties of Steel, A. Pomp

The article presents data on tests, the purpose of which have been to establish the influence of heat treatment on the various physical properties of iron having a low content of carbon. These investigations covered, *first*, material heated and slowly cooled; *second*, heated and immersed rapidly in cold water; and *third*, overheated and regenerated material.

In order to test the homogeneity of the material as it was before the beginning of the test, a number of test pieces were subjected to microscopic investigations with respect to segregation of sulphur, phosphorous and carbon, and it was found that the material was entirely free from segregation phenomena.

The article reports data previously obtained in the same connection by Heyn, and describes in detail the methods of testing used in the present instance. In the series of tests with heated and slowly cooled material, the heat treatment was

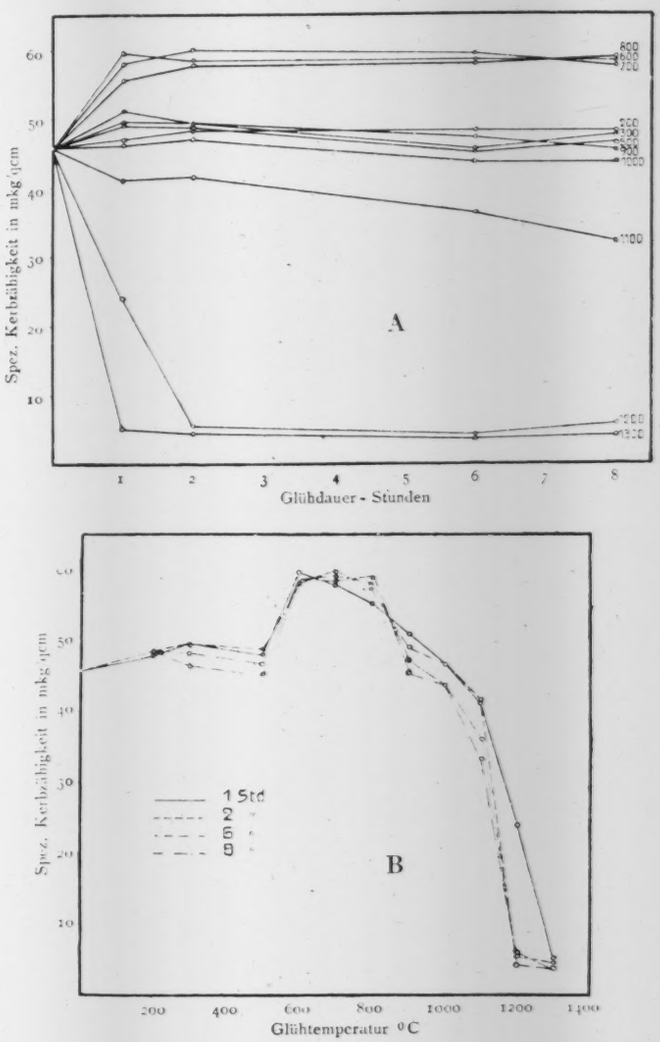


FIG. 1 A, RELATION BETWEEN TENACITY AND HEAT TREATMENT; B, RELATION BETWEEN TENACITY AND TEMPERATURE OF HEATING

(Ordinates: specific tenacity under shock in mkg/qcm: 1mkg/qcm = 46.58 ft.-lb. per sq. in.; abscissae: temperature of heating in deg. cent.; in B, *Std.* = hours)

carried out in the following manner: Eight test bars were placed in a cold muffle and heated to the desired temperature, which took, in accordance with the temperature desired, from 15 to 45 minutes. The final temperature was then maintained constant for a period of 8 hours. At the end of the first hour two test pieces were taken out from the furnace and slowly cooled in infusorial earth. At the end of the second hour, two more pieces were taken out, likewise at the end of the sixth and eighth hours, and all cooled in infusorial earth down to room temperature. The complete cooling took up to twelve hours.

The data obtained in the notch-shock tests are presented in the original article in the form of tables and graphical curves. Only the latter are here reproduced. Fig. 1A shows that the

tenacity under shock varies quite widely as a result of heat treatment. These variations become particularly noticeable during the first two hours of heating, as one can see from the sharp fall of the curve between "zero" and "two" hours. The minimum variation is produced by heating at 1000 deg. cent., while the fall of tenacity is very sharp for 1200 and 1300 deg. cent.

At first glance it might appear as if after a certain period of heating, say one to two hours, there is established some sort of a state of equilibrium which would explain the nearly horizontal course of some of the curves. This assumption is, however, contradicted by the way the curves for 900, 7000 and 1100 deg. cent. run, since with an increase in duration of heating there appears to be a continuation of the fall of tenacity. As a rule the heat treatment produces either an increase or a decrease of tenacity under shock. An increase may be expected at all temperatures under 1000 and a decrease at those above 1000 deg. cent.

When heat treatment produces an increase in tenacity under shock, the maximum value of the latter, characteristic for the given temperature, is reached after one, or at most, after two hours of heating. In the case of heating at temperatures above 1000 deg., there is a continuous decrease of tenacity beginning with the start of heating and increasing with the duration of heating, and this decrease of tenacity occurs more rapidly the higher the temperature of heating is. A separate series of tests were carried out in this connection running the duration of heating up to 30 hours, and these tests fully confirm the above conclusion.

Fig. B shows the relation between tenacity under shock and the temperature of heating. The fully drawn lines correspond to a duration of heating of one hour, the broken lines to that of two hours, the dash lines to a duration of six hours, and those broken in by two points to a duration of eight hours. If one considers the four curves as a whole, one can see that the lines rise slightly from zero to 300 deg. cent., then from 300 to 500 deg. there is a slight decrease of tenacity under shock. From the minimum reached at 500 deg. cent., there is a strong rise of the bundle of curves until at temperatures varying from 600 to 800 deg., a maximum of tenacity is reached, after which there is a rapid fall beginning at 800 to 900 deg. cent., and a new minimum is reached at about 1200 deg. cent. These data do not materially differ from those previously obtained by Heyn.

As regards the variation in the dimension of the granular structure, it was found that when iron with a low content of carbon is heated at temperatures from zero to 1100 deg. cent., the increase in the duration of heating produces a slight growth in the ferrite crystals. At temperatures above 1100 deg. cent., the crystals materially increase with increase of temperature and duration of heating. At the same time, the formerly uniform ferrite polygons change at temperatures above 1100 deg. cent. into structural forms with rough edges and irregular surfaces. (*Einfluss der Wärmebehandlung auf die Kerbzähigkeit, Korngrösse und Härte von kohlenstoffarmem Flusseisen*, A. Pomp, *Ferrum*, vol. 13, No. 4, p. 49, January, 1916, article not finished. *e.*)

Influence of Thickness on Tensile Tests, G. B. Waterhouse

Data of an investigation showing how variations in thickness affect the static properties of open-hearth and Bessemer plate. The work described was carried out in connection with some comprehensive tests on steel plates, and throws some light on the influence of thickness on the results of tensile tests, besides giving comparative results on basic open-hearth and acid Bessemer steel. A brief review of previous literature on this subject is given.

The work done by the writer was on the material known as sheet bar, 8 in. wide and of various thicknesses. The results are given in tables and figures.

The results on the open-hearth steel agree in general with previous conclusions. The ultimate stress decreases as the thickness increases up to about 0.6 in., but after that it is practically uniform and does not show the steady decrease that might be expected from Webster's table. The curve for the elastic limit descends at about the same rate of speed as the ultimate stress, as the thickness increases, but when about 0.6 in. is reached, instead of remaining constant, it steadily descends as the thickness rises. The elongation remains practically constant for all the thicknesses tested, but the reduction of area after remaining comparatively uniform until about 0.6 in. is reached, then descends somewhat rapidly as the thickness increases.

The results on the ordinary Bessemer steel are quite different. The ultimate stress decreases somewhat as the thickness increases, but the decrease is very slight. This is also true of the elastic limit, but here the influence of the thickness is a little more marked. The reduction of area is practically constant until a thickness of about 0.55 in. is reached, and then sinks as the thickness increases.

These results on the Bessemer steel are confirmed by tests made on steel slightly higher in carbon.

On the whole it has been found that acid Bessemer steel is noticeably "stiffer" than basic open-hearth. Further, this comparison brings out clearly the comparatively small effect of the increase in thickness on the tenacity of the Bessemer steel. Some other factor evidently has a greater influence on this property than the change in gage, and this factor may probably be the residual phosphorus of the Bessemer steel. (*The Iron Age*, vol. 97, no. 15, p. 896, April 13, 1916, 3 pp., 3 figs. *e.*)

Peculiar Appearance of Some Sawn Bars

An article showing micro-photographs of a sample of sawn steel bars.

Three illustrations are given, one showing wavy lines appearing as slight irregular ridges in the surface. The bar in question was 3½ in. in diameter, and the sample was cut by a power hacksaw with reciprocating blade. The peculiar markings appear on both sides of the sample and are so located that all centers appear to be on a common plane.

The editor sent it to several metallurgists and chemists and, in addition to the editorial proper, reproduces their answers. The consensus of opinion is that these markings had nothing to do with either the composition or heat treatment of the steel, but were produced by the forces acting on the metal during the process of power sawing.

A power driven hacksaw when in operation is subjected to several forces. One is a force bearing down, while the other principal one is a horizontal or pulling force in the direction of the blade travel. These two forces tend to set up vibrations in the saw blade. There is also some lateral motion of the machine itself introducing a third component in the vibration while the teeth are constantly wearing thinner through abrasion. The combined efforts of these forces would tend to keep the cutting blade bent into a series of corrugations resulting in the oval markings on the specimen under consideration.

Geo. O. Loeffler states that he sawed a piece of shrapnel

bar on a small machine which gave a smooth cut and the waves showed quite clearly and uniformly. He also noticed that the areas intersected at the top and bottom of the bar or at right angles to the blade. He then gave the bar a half turn and made another cut and found the same condition. (*The Blast Furnace and Steel Plant*, April 1916, p. 157, 3 pp., 5 figs. *dt.*)

Fuel and Firing

POWDERED COAL IN THE OPEN-HEARTH FURNACE

A report of a paper read by C. J. Gadd, Chief Engineer of the American Iron & Steel Manufacturing Company, on April 6, before The Franklin Institute of Philadelphia.

3. By reason of their high radiating capacity, the infinite number of minute incandescent particles in the powdered coal communicate the heat by radiation, and not by convection, thus eliminating the necessity of bringing the surrounding air to the temperature of the coal particles;
4. All the heat in the waste gases is conserved and used in the production of steam.

The extra fuel consumed, due to the use of cold air, is offset by:

1. The elimination of all loss in the gas producer process;
2. The elimination of all loss due to frequent reversals;
3. The elimination of all loss in waste heat taken up by the regenerative chambers;

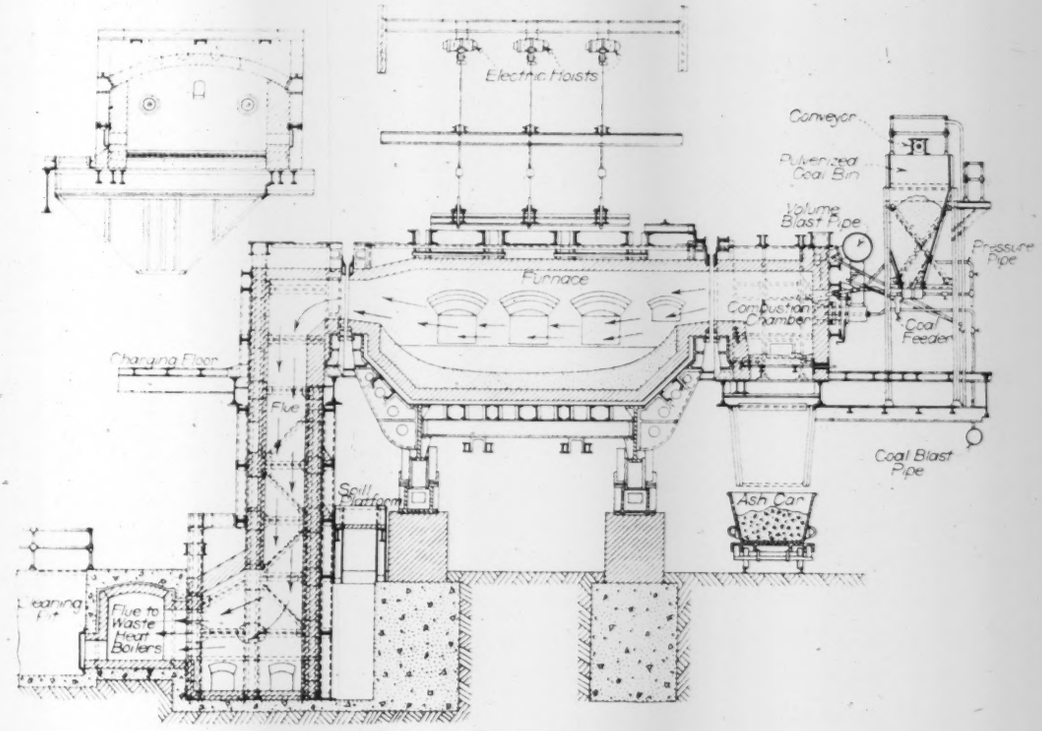


FIG. 2 A, OPEN-HEARTH FURNACE HEATED BY POWDERED COAL

The author recounted briefly the experiments with different forms of burners applied to open-hearth furnaces and showed the cross section of an open-hearth furnace fired at one end and operated without generators (Fig. 2A). With this furnace is connected an interesting arrangement of waste-heat apparatus, involving two steam boilers and an economizer, both arranged so that they can be by-passed when necessary for repairs, so as not to shut down the furnace plant. Other applications of powdered coal burning in iron metallurgy were shown. The installation represents a somewhat radical departure from the old time theories of open-hearth furnace practice. The burners are arranged at only one end of the furnace and the path of the flame is always in one direction. The theory underlying this method of applying powdered coal in the open-hearth furnace is given by the author as follows:

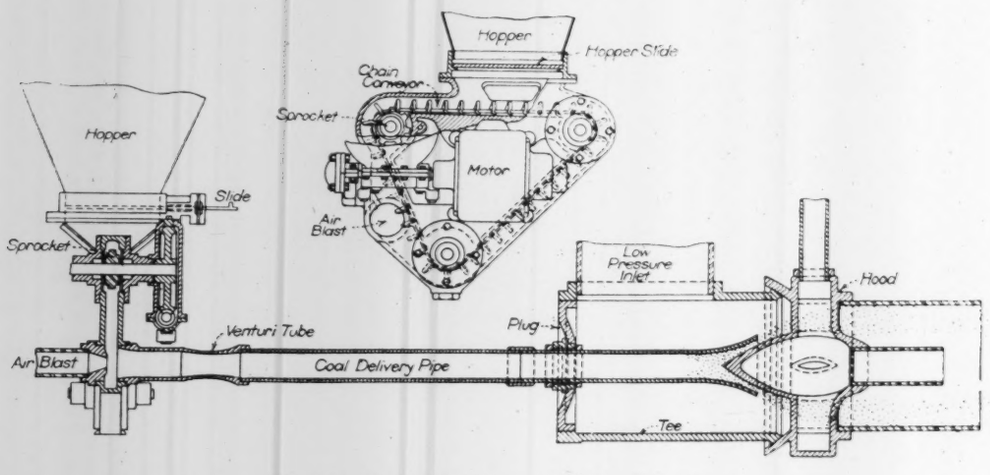
1. The fuel is burned above the bath, and all the heat contained in the coal is instantly developed in the furnace;
2. As the path of the flame is in one direction all parts of the furnace are maintained at the same temperature;
4. The elimination of the expensive maintenance cost of producer plant and regenerative chambers;
5. The greatly reduced first cost of installation.

The article describes in detail the methods of distributing and storing powdered coal and the methods of preparation of the fuel. In the latter connection the author calls attention to the fact that it is easier to dry coal to one half per cent moisture or less than it is to maintain it in this state. He explains it as follows:

The moisture driven off from the coal in the process of drying saturates the hot air contained in the dryer cylinder. In this highly saturated condition the air follows the dried coal through the dust-proof conveying system to the enclosed storage bin. As the coal and air cool, moisture is precipitated and the volume of the air diminished with the result that more warm saturated air is drawn from the dryer. The precipitation of moisture resulting from the cooling process of the coal and air may be almost entirely overcome by placing ventilating shafts on the storage bin and the high points of the con-

veying system connected with the outside air. However, in the process of drying through the medium of heat a small quantity of the expelled moisture will find its way back in the coal after cooling, and for this reason it is good practice to gage the dryer so that the resultant product leaving the dryer will contain less than one half per cent of moisture.

One of the most interesting parts of the paper is that concerned with the burners. Fig. B shows a low pressure powdered coal burner with its feeding apparatus. An endless flight conveyor chain is used for feeding a stream of powdered coal in a continuous shower across the air blast ports. The excess fuel is automatically returned to the hopper by the endless flight conveyor chain. The air blast inlet nozzle connected with one side of the feeder case is reduced, the outlet side being flared, beyond which is a venturi tube used to induce higher velocity of the mixture leaving the feeder, thereby causing a slight vacuum or pull throughout the case. The cone extension on the hood of the burner enters the flared end of the coal delivery pipe, breaking the solid shaft of coal and air and deflecting it around the inner periphery of the burner pipe. The mixture takes the form of a hollow ring, in the center of which an auxiliary blast is discharged giving a thorough atomization of the fuel particles as they enter the furnace.



B, LOW-PRESSURE POWDERED COAL BURNER

Sectional elevations of mechanically operated high pressure powdered coal feeding apparatus are likewise given. Feeders and burners of the high pressure type produce a long flame through progressive combustion and can only be used where the form of the furnace and the character of the work demand that an elongated cutting flame be developed in close proximity to the work done. This method of application is adapted to open-hearth furnace practice. In the type of feeders and burners described, the results obtained are equally good whether the powdered coal is injected into the furnace from the burners at a velocity of 1500 ft. per minute, or of 25,000 ft. per minute.

The author puts the personal equation forward as the important factor in the operating part of the apparatus as developed thus far. In fact, he says that it is necessary to depend too greatly upon this uncertain element. In the drying process the operator may at any moment upset the complete equilibrium of a plant either by overheating the coal or by not drying it enough. In the furnace operation three or four separate adjustments are required depending on the burner used, each adjustment bearing a fixed relation to the others. These adjustments are the control of the coal feed, the control of the coal blast, the control of the volume blast and the control of the furnace draft where mechanically operated by low pressure feeders and burners are employed. (*The Iron Age*, vol. 97, no. 15, p. 890, April 13, 1916, 6 pp., 9 figs. *dA.*)

A TEST OF A SURFACE COMBUSTION FURNACE, E. Schramm and J. R. Cain

Description of some tests made on a surface combustion furnace to determine its performance and best conditions of operation.

The article fully describes and illustrates the methods of testing. The furnace was operated without a charge. A cover was placed so as to almost close the top of the muffle, thus reproducing normal operating conditions and avoiding loss by radiation from the incandescent bed. In a preliminary run it was established that at high temperatures the furnace reaches steady conditions after about half an hour run. The same tests have shown that a temperature of about 1650 deg. cent. (3000 deg. fahr.), was reached in a little over half an hour and maintained for ten minutes with a gas consumption of 3 cu. ft. per minute. It has been further found that the rate of cooling of the furnace is very slow because of the heat storage of the incandescent bed and the efficient insulation of the walls, a property which makes this type of furnace convenient for certain laboratory operations.

A curve is plotted with the ratio of air to gas in the mixture against the percentage of oxygen in the flue gases. This curve, together with the flue-gas analyses given in the article, established that a ratio of air to gas of 5.5 gives most nearly the ideal conditions of perfect combustion without any excess of oxygen, and this ratio gives also the highest temperature for any given gas consumption. From comparison of data of gas consumption for mixtures in the ratios 5.5 and 6.5 it has been found that a 20 per cent excess of air causes a lowering of furnace temperature of about 100 deg. cent. (180 deg. fahr.)

The highest furnace temperature reached during the tests described was 1675 deg. cent. (3045 deg. fahr.), but the temperature of the porous mass must have been considerably higher. It should, however, be pointed out that the refractories ordinarily obtainable will not permit the operation of a furnace above, or indeed, for any length of time, as high, as 1650 deg. cent. (*The Journal of Industrial and Engineering Chemistry*, vol. 8, no. 4, p. 361, April, 1916, 5 pp., 6 figs. *e.*)

Heating

LOSS OF HEAT IN HOT-BLAST MAINS, R. J. Wysor

In making efficiency tests on the hot blast stove at the Bethlehem Steel Company's plant, the author found a marked difference in temperature as indicated by a pyrometer inserted near a stove on blast and the regular recording instruments situated near the bustle pipe. Hence a special hole was provided at the junction of the hot-blast main and the bustle pipe and portable pyrometers with bare fire ends were used, both at this point and in the stove necks. Similar experimental work has been also done by H. A. Brassert, superintendent of blast furnaces, South Works, Illinois Steel Co., who found temperature drops of the same order of magnitude.

In the course of this investigation, the author determined the average thermal loss due to cooling water from each hot-blast valve with an average blast temperature of 1360 deg. fahr. and a volume of about 33,000 cu. ft. free air per minute under standard conditions, to be approximately 10,000 B.t.u. per minute. The general conclusions arrived at by the author are as follows:

First.—Between the stoves and the blast furnace there is a very marked drop in the temperature of the hot-blast, which is not only serious as to temperature, but signifies also a thermal loss. It is affected by many variables, such as size and length of hot-blast mains and connections, thickness of fire brick linings, volume and initial temperature of air passing per unit of time, temperature and wind velocity of the outside air, extent of water cooling, etc. It is probable that, at a great many furnace plants in the country, these losses are of sufficient magnitude to justify an attempt at their reduction. The present tendency is toward higher blast heats on furnaces carrying large percentages of Mesabi ores in their mixtures; and high heats have always been desirable in smelting hard, coarse ores, such as the magnetites so generally used in the east. In the manufacture of spiegel and ferromanganese, the maintenance of high blast temperatures is of particular importance. This is particularly important in all plants where economy in the use of blast furnace gas must be practiced, owing to large consumption in gas engines or under boilers.

Second.—Insufficient insulation in the hot-blast main is the cause of serious temperature and heat losses. It seems logical and practicable to prevent a large percentage of these losses by means of one of the methods of insulation suggested in this paper. With such insulation, other operating conditions being normal, we would expect higher available blast heats with resulting fuel economy, or a smaller quantity of fuel gas necessary for heating the stoves. It is believed that blast-furnace managers and superintendents generally will be interested in a study of better insulation of the hot-blast main and stoves. (*The Iron Trade Review*, vol. 58, no. 8, p. 435, February 24, 1916, 4 pp., 4 figs. *e.*)

Hydraulics

LEAKAGE FROM LEAD JOINTS IN CAST-IRON WATER PIPES, Arthur H. Smith

Discussion of the leakage from water pipes in city mains and their connections.

The leakage losses from a water works system may be due to the following three causes: (*a*) Leaking of underground mains; (*b*) broken or abandoned service pipes; (*c*) defective plumbing fixtures. It is of interest to note that the amount of leakage due to all causes combined is usually surprisingly high. The general experience of water works men who have studied this particular phase of leakage seems to be that from 30 to 40 per cent of the total supply which enters the system is unaccounted for, that is, only 60 to 70 per cent is delivered for legitimate purposes, the rest being lost as leakage.

A test for leakage has been conducted on a small new public water works system at Medway, Mass. There the sources of supply are driven wells from which water is pumped through the distribution system to a stand pipe 30 ft in diameter by 80 ft. high whose capacity per foot in height is thus 5288 gal. The distribution system is made up of cast iron pipes 6 in. to 12 in. in diameter, class E, New England Water Works Association specifications. The lead in the 6 in. sockets is 2 in. deep and in the 8 in., 10 in., and 12 in. sockets, 2½ in. deep.

At the time of the test the system had been entirely completed with the exception of service connections, none of which had been put in. With the stand pipe filled and with pumps stopped, the observation for leakage was made for a 24 hr. period by simply noting the rate of lowering of the water level. A careful inspection of the entire route of the pipes revealed no evidence of much leakage and it is believed that practically all was at lead joints.

The total loss in 24 hours was found to be 22,400 gal., which with proper corrections showed a net loss in the underground mains of 20,800 gal. or 1.58 gal. per day per linear foot of lead joint. The possible errors in determination ought not to exceed 5 per cent. These results are fairly representative for the size of pipe and class of work.

So long as pipe lines are built in the present manner, leakage must be reckoned with. In the endeavor to reduce it to a minimum, two general lines of action are possible: *first*, the substitution of some more satisfactory material than lead, and *second*, an improvement in the design and construction of the lead joint. The author believes that if leakage on new work can be limited to *one* gallon per day per foot of joint under 100 lb. pressure, the performance can be called good and acceptable. (*Journal of the New England Water Works Association*, vol. 30, no. 1, p. 1, March 1916, 19 pp. *pe.*)

VALVES FOR USE IN WATER WORKS

REASONS FOR ADOPTING THE SOLID-WEDGE TYPE OF VALVE IN THE BOSTON WATER DEPARTMENT, George H. Finneran

Discussion of the solid-wedge type of valve for use in water works.

The Boston Water Department manufactures its own gates, hydrants, bronze fittings, etc. In determining what type of valve to adopt it decided in favor of the solid-wedge type as compared with the loose double disc, because 67 years of experience has developed no convincing reasons why the solid wedge type should be discontinued.

In considering the merits of the respective types, the engineers of the Water Department were impressed by the fact that there is practically but one seat to a valve in operation and that is the seat opposite to the side on which the pressure acts; hence the superfluousness of the second disc in the double seating plug of the expansion type. Further the engineers took into consideration the uncertainty of the double-disc type of valve in overcoming rust and other solid matter that is generally encountered between the seats of valves infrequently operated, as against the ability to dislodge with the solid-wedge an amount of such matter sufficient to allow of tight closing valve by manipulating, that is, raising and lowering the wedge and crushing and washing out the obstructing material. The horizontal movement of the expanding disc is more apt to

drive the matter against the seats with such force as to adhere and prevent tight closing.

As a point against double-disc valves, also, the opportunity was considered for rust or other matter to accumulate between the discs and adhere to the various knuckles, hinges, wedges, trunnions, etc., of the operating mechanism, clogging them and interfering with their action. In waters of heavy lime content or those with corrosive constituent, the effect would tend practically to put the valve out of commission. Generally in a large city where a gate is frequently operated by unskilled and indifferent men, a plain rugged type of valve is almost a necessity.

REASONS FOR USING THE DOUBLE-DISC TYPE OF VALVE, J. M. Diven

This paper presents reasons in favor of the double-disc type of valve although the author states that he had no recent experience with solid-wedge valves but has used the double or parallel disc type of valve.

He gives a brief history of valves, starting from the solid wedge type imported from England in the early days of water works construction. The next was the Peet valve, a taper seat type, of the wedge principle. Various devices have been contrived for expanding the discs to their seats, but the writer believes that while the discs are free to adjust themselves to their seats there should be as little lost motion as possible between the discs and seats so that when operated, the discs are in practical contact with the seats, thus shearing off an accumulation of rust, sediment, or foreign substance.

An objection to the solid-wedge type is the fact that the gates always seat in the same place and when foreign substance is trapped between the gate and the seats, the seats would become so damaged that the gate would leak. In parallel-seated or double-disc valves, the gates do not seat twice in exactly the same place. Therefore, should solid matter be caught between the gate and the seats, the marring will not cause serious damage as the dent in the disc will not come opposite the corresponding one in the seat and the compensating feature of the parallel seat valve permitting a certain amount of give, takes care of some irregularities in the contact parts. (*Journal of the New England Water Works Association*, vol. 30, no. 1, pp. 101 and 106, March 1916, 18 pp. and 1 fig. *dcp.*)

Internal Combustion Engineering

KLINE ROTARY VALVE

Description of a new rotary valve construction patented by H. J. Kline.

By using an automatic auxiliary exhaust valve in conjunction with the main or rotary valve, the former, controlled by the piston, may be so designed that it will carry away a large part of the heat of the exhaust. At light loads when the throttle is only slightly open, the exhaust pressures within the cylinder are such that the automatic valve is supposed to barely lift, but at full loads where the exhaust pressure is very high, the valve should be forced wide open to carry away at the lower end of the cylinder, the larger part of the exhaust gases and consequently the major portion of the heat.

A further problem is created by the necessity of securing a proper fit of the valve and to maintain a gas-tight joint after some wear has occurred. The Kline valve rotates toward the cylinder so that when pressure is applied by way of the ports leading to the combustion chamber the valve will be placed against the opposite side of the casing.

The packing is used only as a safeguard. The packing rings do not revolve with the valve but creep slowly around, due to the cylinder pressure forcing them against the sides of the grooves in the valve. It is claimed that this creeping action will slowly wear the ends of the packing strip so that it will gradually settle as the valve wears and will still continue to keep this point sufficiently tight. (*The Automobile*, vol. 34, no. 11, p. 500, March 16, 1916, 1 p., *d.*)

THE FREDERICKSON ENGINE

Description of a two-stroke cycle aeronautical engine. By means of an oscillating base valve operated by the connecting rod the engine practically does away with crank case compression. The operating principle is as follows:

Gas from the carburetor or mixer enters the crank case. At the inner dead center of the piston, the valve between the crank case and inner half of the cylinder is opened; during the outward stroke of the piston, gas from the crank case is drawn through this valve into the inner half of the cylinder and at the outer dead center the valve is closed. This valve is operated entirely by the side motion of the connecting rod. There are no gears, eccentrics, chains or cams.

During the inward stroke of the piston the gas in the inner half of the cylinder is compressed until the piston nears the end of its stroke, when the compressed gas is released into the combustion chamber, forcing out the burnt gas from the previous explosion through an exhaust valve or port, the opening and closing of which is so arranged that while practically all the burned gas is expelled, all of the unburned is retained. The piston on its outward stroke compresses this gas in the combustion chamber, at the same time drawing another charge of gas from the crank case into the inner half of the cylinder, which in this case forms the primary or low compression chamber. Near the outer dead center, the gas in the combustion is ignited, forcing the piston toward the center.

No data as to tests or performances of this engnie, or speed and power output are given. The article is illustrated by two section diagrams and a view of the engine as installed on an aeroplane. (*Aerial Age Weekly*, vol. 3, no. 4, p. 120, April 19, 1916, 2 pp., 3 figs, *d.*)

A GAS TURBINE

Some information concerning the work done at the plant of the Brown-Boveri Co. in Baden. According to the article recent correspondence indicates that their work on the gas turbine has finally been brought to a state of practical working efficiency. The turbine is designed and operated on the impulse principle. (*The Gas Engine*, vol. 18, no. 4, p. 191, April, 1916, 1 p. *gd.*)

THE DETROIT GAS TURBINE

Some data concerning a gas turbine said to be built in Detroit, Mich. According to the article it consists of a gas compressor with eight compressing cylinders for supplying the compressed gas to the firing chambers. Each cylinder supplies complete charge at each revolution in all eight impulses at each turn of the driving shaft. Since the speed of this driving shaft will ordinarily be 3000 r.p.m., this will mean approximately 24,000 explosions per minute upon a 23 in. rotor; each explosion or impulse directs its energy upon 7.75 sq. in. of rotor surface at a constant pressure of about 115 lb. per sq. in. No precise data of the construction or of tests are given in the article. It is only stated that the 200 h.p. turbine will weigh 345 lb. complete and that at present time it is proposed to furnish only three models, of 100, 200 and 300 h.p. units. (*The Gas Engine*, vol. 18, no. 4, p. 193, April, 1916, 2 pp. 2 figs. *d.*)

The editor has secured a catalogue of the corporation handling these turbines and this catalogue describes the operation of the turbine in the following manner (Fig. 3).

As the compressor piston moves downward the gas is drawn into the compressor cylinder and as it starts to move upward the gas is passed into the firing chamber of the follower valve. This action is controlled by the ports and passages.

As the compressor piston moves downward, the follower valve moves upward until the intake port comes opposite the cylinder port. The follower valve has moved upward to its highest position while the compressor piston is moving to its lowest point of travel. As the compressor piston commences its upward movement the follower valve is moved down until the top edge of the gas transfer port is in the same plane with the cylinder port.

When the compressor piston has reached its highest point of travel the follower valve moves upward, carrying the compressed charge of gas in the firing chamber at a pressure of about 90 pounds per square inch.

As the follower valve moves upward, the gas transfer port

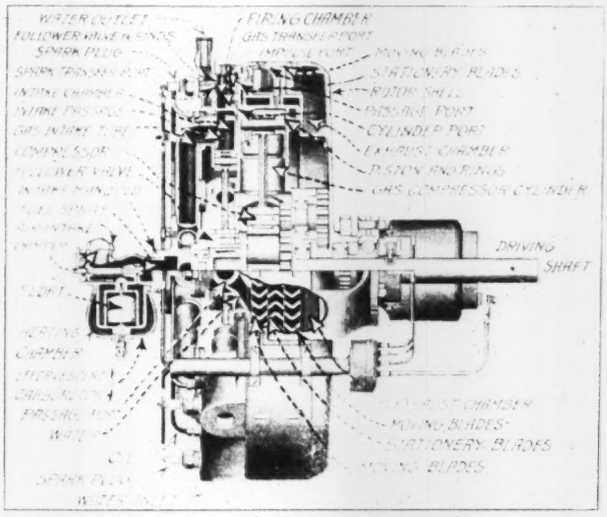


FIG. 3 DETROIT GAS TURBINE

and cylinder port are closed to each other and at a predetermined distance of the impulse port below the passage port the ignition of the charge of gas takes place by directing an electrical spark through the spark transfer port. At the moment of complete combustion and when the exploding gas has reached its point of greatest expansion, the impulse port is opened instantly directly opposite the passage port and the charge is directed through the channel and nozzles onto the first row of moving blades.

As the gas is driven at high pressure upon the first row of moving blades, their form is such that they absorb and transmit a large percentage of the power to the rotor, while the gas is deflected to another set of stationary blades which in turn directs the still expanding gases upon the second row of moving blades, also attached to the rotor and moving in the same direction as the first.

The catalogue gives the following principal dimensions for a 100 h.p. turbine: Diameter of rotor, 22 in.; weight complete, 286 lb.; speed of rotor limited to 12,000 r.p.m.; permissible speed of driving shaft, 4000 r.p.m.; mean effective pressure of exploding gas on rotor vanes, 115 lb. per sq. in.

The catalogue of the company does not make any mention of any tests of the turbine and does not state whether any have been so far practically used.

THE COMPOSITION OF THE EXHAUST FROM LIQUID-FUEL ENGINES, Robert W. Fenning

The paper has a two-fold object: *first*, to describe a method of constructing exhaust-gas charts for suitable fuels *without the use of an engine* and to set forth the results of numerous experiments relating thereto; and *second*, to increase the evidence as to the composition of exhaust gases, especially with reference to the combustible products obtained when using strong mixtures. In the course of the investigation several exhaust-gas charts have been prepared.

The author gives the name *exhaust-gas chart* to the set of curves obtained by plotting on a strength-of-mixture base the percentages of carbon dioxide (CO_2), cabon monoxide (CO), and oxygen (O_2) in the exhaust gases, the strength of the mixture being expressed as the ratio of air to fuel by weight. The author did not use an actual engine in the majority of his experiments which consisted mainly in the preparation of mixtures of air and vaporized fuel in known proportions, the explosion of some of the mixture in a small explosion vessel, and the complete analysis of the resulting products of the combustion. Exhaust samples were, however, also taken from an engine fitted with Dr. Watson's apparatus for measuring air and fuel, and these samples were analyzed. Comparisons

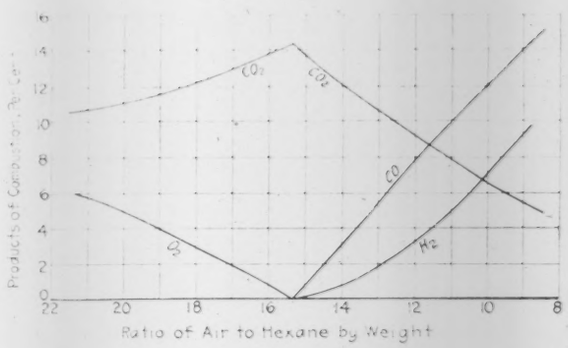


FIG. 4 HEXANE "EXHAUST-GAS CHART" EXPLOSION-VESSEL TESTS

were then made between the composition of the products of combustion resulting from explosions in a small explosion vessel and in an actual engine.

The fuels used were hexane (C_6H_{14}), benzene (C_6H_6), gasoline and commercial benzol. The article fully describes the methods of preparation of air-fuel mixture, explosion of mixture, and analysis of products of combustion, as well as gives a general discussion of results. A sample of an exhaust-gas chart from explosion vessel tests on hexane is given in Fig. 4. The conclusions from the experiments above referred to are expressed by the author as follows:

a With volatile fuels there is but little difference in the composition of the products of combustion resulting from air-fuel mixtures in a small explosion-vessel or in an engine cylinder, in spite of the conditions being so dissimilar. In fact, the agreement between the CO_2, O_2, and CO values in engine and explosion-vessel tests is so close that an exhaust-gas chart prepared from explosion-vessel tests can be used to estimate the strength of mixture supplied to an engine.

b A very small quantity, if any, of unsaturated or saturated hydrocarbons is present in engine-exhaust gases. Taking a particular instance, methane is almost entirely absent.

c The hydrogen constituent in exhausts from strong mixtures

is an important item, and increases in value rapidly with increase in mixture strength.

d The ratio of air to fuel in the original mixture can be calculated with a considerable degree of accuracy from the composition of the exhaust gases.

e The reliability of Dr. Watson's method and apparatus for measuring the air and fuel supplied to an engine is once more demonstrated.

Exhaust-gas charts such as described in this paper may prove useful in engine testing both for estimating the mixture strength and for determining the waste of heat due to incomplete combustion. Likewise they may prove useful for setting carburetors and thus promoting fuel economy. (*The Institution of Mechanical Engineers*, Advance Paper C, read March 17, 1916, 38 pp., 9 figs. *eA.*)

Lubrication

A SYSTEM FOR PLOTTING AND CROSS-FAIRING RESULTS IN LUBRICATION TESTING, Professor G. B. Upton

Description of a method of plotting the results of lubrication testing which makes possible cross checking of values for both relative and absolute accuracy. The tests were made with hard bronze bearings in a Thurston lubrication testing machine.

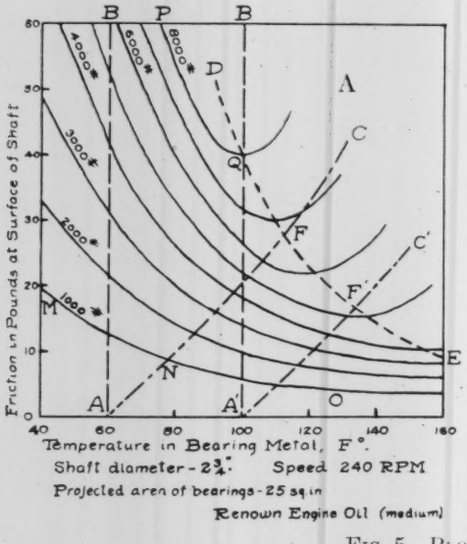
The main plot is shown in Fig. 5A. The kind and supply of lubricant and speed of shaft were kept constant throughout a series of tests, among which the only impressed variable was the load on the bearing. For each load there is plotted a curve such as *MNO*. The curves in the figure are labeled with their appropriate bearing loads in pounds.

One variety of cross plotting and fairing of the curves is possible by taking the values of the intercepts of the various load lines on a vertical line of constant temperature such as *AB* or *A'B'*. The resultant curve of *friction vs. load* at constant temperature has a small positive intercept of friction for zero load, then increases about in proportion to load until the seizing load for the bearing is approached, and the curve turns abruptly upward. Another cross plot comes from dividing each friction value by the corresponding load, that is, obtaining the coefficient of friction and plotting that against load as in curves *AA* and *BB* in Fig. B, *AA* being for constant temperature of 60 deg. fahr. and *BB* for 100 deg. fahr. in the bearing metal.

The much more important curve is *ANFC* which is the locus of "equilibrium temperatures," or temperatures at which a balance is reached between the gain and loss of heat due on the one side to the bearing getting hotter, and on the other side to decrease of friction as the temperature rises. For the curve *ANFC* the temperature intercept at zero friction must be the room temperature. The locus of equilibrium temperatures is independent of the curves of *friction vs. temperature* at various constant loads such as *MNO*, Fig. A. It is superimposed upon those curves.

To find the curve of equilibrium temperatures, two series of constant load runs were made, the first series with loads increasing from one run to the next and the second series with load decreasing. Equilibrium is reached when the ratio of friction times speed to difference of temperature between bearing and room becomes constant. The dotted curve *DQFF'E*, Fig. A, is the locus of minima of the constant load curve.

The real criterion of safety of the bearing comes from the relations of the constant load curves, the locus of equilibrium temperatures and the locus of minima of constant load curves. If a constant load curve cuts the locus of equilibrium temperatures while the constant load curve is descending, the bearing will come to equilibrium and be entirely safe as it will have no tendency to get hotter. If the room temperature be raised and the new equilibrium temperature curve is different, the safe loads for the bearing are greatly changed.



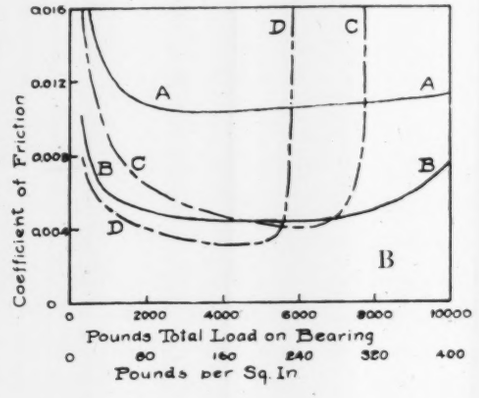


FIG. 5 PLOTS OF LUBRICATION TESTS

In chart B, the bearing temperature constants are, 60 deg. fahr. for curve *AA*, 100 deg. fahr. for curve *BB*. Bearing warming to equilibrium, room temperature constant to 60 deg. fahr., curve *CC*, 100 deg. fahr, curve *DD*.

The effect of the environment on the coefficient of friction of a plain bearing has generally received less attention than it should. The curves *CC* and *DD* of Fig. B have as their only cause of difference the change of room temperature from 60 deg. to 100 deg. fahr. The higher room temperature gives a lower coefficient of friction at the expense of load carrying capacity. The author points out that a study of the curves of Fig. B and comparison with Fig. A will show the unreasonableness of quoting coefficients of friction in lubrication or bearing tests without the most complete statement of all the conditions under which the test was made. (*The Sibley Journal of Engineering*, vol. 30, no. 6, p. 194, March 1916, 3 pp., 2 figs. *et.*)

Machine Parts

SPECIAL SPRING SUSPENSION FOR TRUCKS AND AUTOMOBILES, M. C. Krarup

The article presents data from an exceptional installation where by larger flexibility and range of action of the spring suspension, an increased load capacity has been gained. A construction of this particular spring (rear suspension) is shown in Fig. 6 (in the original article another figure is given showing the front suspension).

The rear end of each leaf spring supports the frame of the vehicle through the intermediation of a large supplementary helical spring of the railroad truck spring variety. The movements of the leaf spring as well as of the coil spring are guided by means of a 15-in. lever, with bar and shackle connection, and these levers on opposite sides of the vehicle are tied together with a cross-bar and, therefore, the cross-bar forms the pivotal axis for the turning movement of the two parallel levers. The arrangement is such that one-sided shocks can be compensated by the choice of the spring dimensions, and the cross-bars almost equalize the forces acting upon the two helical springs of a pair whether they are at the ends of a cross-bar or closer together. The supplementary helical springs add to the flexibility of the suspension. With the range of action in one of these coil springs of 6 in., the additional range of action produced by the axle is about 3 in.

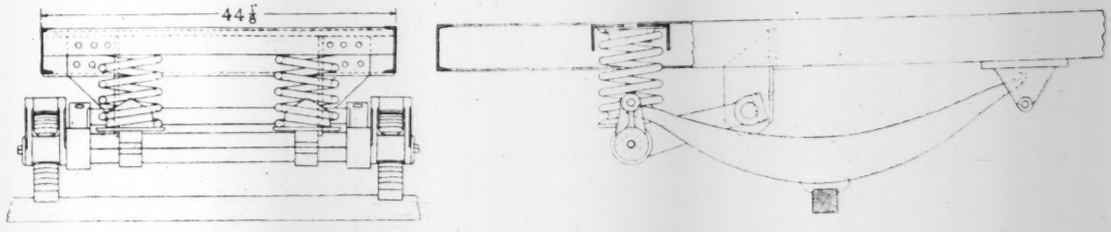


FIG. 6 WILLIAMS REAR-AXLE SUSPENSION FOR BREWERY TRUCK

if the action is at the middle of the leaf spring, but the slight angularity of the whole spring movement, especially in front, modifiies this relation only a trifle.

If plain leaf springs of a flexibility corresponding to that of the suspension described were used, the results, as far as undesirable large movements are concerned, would be acceptable. One factor to which the writer calls particular attention is that the arrangement by which the guide levers enter between the two spring elements on one side in such a manner that the compression of both leaf and coil springs on one side causes only the compression of the coil spring on the other side but not that of the leaf spring; on the contrary, it tends to extend the latter. (Results from a Special Spring Suspension Developed for Brewery Trucks and Applicable to Automobiles, Marius C. Krarup, *The Automobile*, vol. 34, no. 11, p. 493, March 16, 1916, 5 pp., 3 figs. *dc.*)

Machine Shop

CHISELS, Henry Fowler

Discussion of the metal used for chisels and standardization of their shapes.

In the Chief Mechanical Engineer's department of the Midland Railway (England), after considerable experiment, it was decided to order chisel steel to the following specifications: "carbon, 0.75 to 0.85 per cent, the other constituents being normal" (manganese, 0.30, silicon, 0.10, sulphur, 0.025, phosphorous, 0.025 per cent).

Fig. 7 shows the most important forms of chisels used in the locomotive shops. They are made to stock orders in the smithy and forwarded to the heat treatment room where the hardening and tempering is carried out on batches of fifty. Since the chemical composition is more or less constant, the chief variant which causes the temperatures to be varied slightly, is the section. The chisels are carefully heated in the gas furnace to a temperature of from 730 to 740 deg. cent. (1346 to 1364 deg. fahr.) according to section, and then quenched to a depth of ⅜ in. to ½ in. from the point, in water, after which the whole chisel is immersed and cooled off in a tank containing linseed oil. This is followed by tempering in an oil bath. (*The Institution of Mechanical Engineers*, Advance Paper D read on February 18, 1916, *dp.*)

Measuring Apparatus

DYNAMOMETER FOR DETERMINING HORSEPOWER OF TRACTORS

To determine the horsepower delivered at the drawbar of a tractor it is necessary to take into consideration three factors, namely, pull, distance and time. The ordinary commercial dynamometer records only the element of pull, which makes it difficult to obtain a net result in terms of horsepower owing to the liability of error in measuring the distance and elapsed time. Another difficulty with recording spring dynamometers is that the recording mechanism must be mounted directly on the dynamometer. The dynamometer is then subjected to very severe usage which interferes with the accuracy of the recording mechanism and sometimes puts it out of commission entirely.

To overcome these difficulties, the Hyatt Roller Bearing Co. has developed a special recording dynamometer for traction engine testing. It consists primarily of an hydraulic pressure unit which is hitched between the tractor and the load being pulled, and a recording pressure gage connected to the hydrostatic unit by means of a flexible tube. The dial of the recording gage is driven by a gear reduction connected by means of a speedometer shaft to a trailer wheel which runs on the ground. To obtain the elapsed time an accurate clock is provided having a recording arm which checks the time intervals on the margin of the pressure gage chart. Hence the three factors for obtaining the delivered horsepower are all automatically recorded on one chart so that it is unnecessary to take any measurements as to the distance or observations as to the elapsed time.

The article contains an illustration showing the dynamometer set up for testing a tractor plow. The illustration in Fig. 8 shows the chart about one-third completed. The broad wavy line on the chart represents the drawbar pull which is recorded by the pressure gage arm nearest the center of the dial. The narrow jagged line on the margin of the chart represents the time which is recorded by the clock arm on the right side of the dial. The capacity of draw-

bar pull was 2500 lb., and the dial geared to revolve once for 4000 ft. of travel. The average drawbar pull of the chart shown is 1130 lb., the total distance traveled 1600 ft. and the elapsed time 12 minutes. The net drawbar horsepower delivered is, therefore, 4.6 h.p. (How Many Pounds Will the Tractor Pull? *Gas Power*, vol. 13, no. 10, p. 50, April 1916, 2 pp., 2 figs. *d.*)

Railway Engineering

THE EMPTY AND LOAD FREIGHT BRAKE, Walter V. Turner

The author points out that in America vast expenditures have been made for grade and curve reduction, heavier motive power, heavier rails, better road-beds, etc., all with the idea

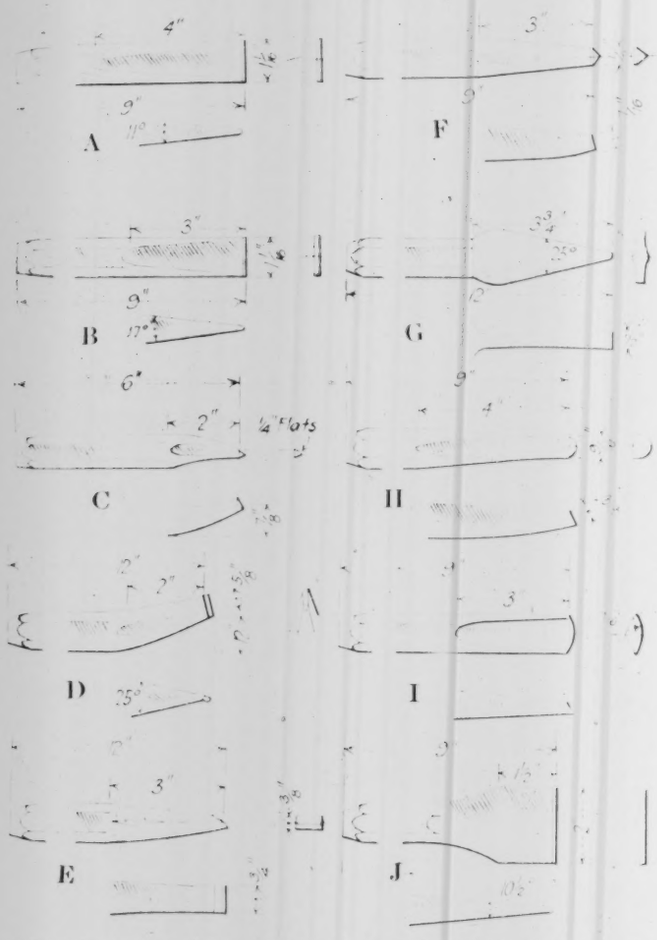


FIG. 7 CHISELS: A, HEAVY BRASS WORK; B, HEAVY IRON AND STEEL CASTINGS; C, CYLINDER REPAIRS (RIGHT HAND); D, SIDE TOOL (RIGHT HAND); E, SQUARE NOSE; F, DIAMOND POINT FOR JAGGING; G, LONG CROSS CUT; H, ROUND NOSE; I, GOUGE TOOL; J, METAL TOOL

of increasing the volume of traffic and of reducing operating expenses by running more trains composed of a greater number of heavier cars. But that end is not yet attained, because of the frequent damage to long trains even in level districts due to slack action, which is in turn due to the fact that the retardation is not uniform between the empty and the loaded cars of the train. The same conditions tend to restrict lengths of trains in hilly districts, as safety in descending grades is the limiting condition of traffic.

The secret of the elimination of slack action lies in uniform retardation on all cars, empty or loaded, in the train. Other things being equal, the retardation set up is proportional to the braking ratio, and the problem is by no means solved by increasing the braking ratio on the empty car, since doing so increases the braking ratio above 15 per cent when the car is loaded.

The paper presents an interesting discussion of the matter of elastic impact between two cars. The empty and load brake as designed for freight service, has two distinct braking forces due to the operation of one or of two brake cylinders during brake applications. The full service braking force obtained with the one cylinder is 60 per cent of the empty weight of the car and is used with the empty or partially loaded car, but when the car is loaded beyond a certain point the second brake cylinder is cut into action to assist the first. Starting with 60 per cent braking ratio for the empty car, the braking ratio for the fully loaded car drops to 15 per cent when the loaded weight is four times the empty weight of the car, as in the case of the new 180,000 lb. capacity hopper cars for the Pennsylvania R. R., weighing 60,000 lb. empty.

The lower braking ratio for freight service is especially

FIG. 8 DYNAMOMETER CHART OF TRACTOR HORSEPOWER TEST

desirable also from another point of view besides the one of having empty and loaded cars braked uniformly when the same cylinder pressure obtains on each. The greater safety, control capacity and economy possible by the use of the empty and load brake equipment is illustrated by the fact that when the same brake pipe reduction was made with a 90-car train having 30 empty and load brake equipments on the head end and also with a 90-car train of single capacity brake equipment, both on a tangent of 1½ per cent grade and at a speed of about 21 miles per hour, the train with the empty and load equipment on the first 30 cars was stalled, whereas the speed of the other train was only reduced to about eight miles per hour.

The results demonstrated the advantages of the empty and load equipment, compared to the single capacity brake equipment in permitting the handling of a similar tonnage with greater economy, safety and reserve capacity or for increasing the capacity of the road by increasing the amount of tonnage which can be handled down the grade with the same degree of safety and economy heretofore possible.

The average brake pipe reduction required to control the 90-car train with 30 empty and load brake cars on the head end was only half as great as with the 90-car train of all single capacity brakes. The single capacity brake train could not be recharged as promptly or as uniformly as the other, because 100 per cent heavier brake pipe reductions had to be made. In consequence of this the speed of the single

capacity brake train down the grade was more uneven and the brake pipe pressure restored at the rear end during the successive recharging periods while descending the grade steadily decreased.

The average speed on the grade was about 16½ miles per hour for the train without empty and load brakes and about 19 miles per hour for the train having 30 empty and load equipments. This, considered in connection with the lower average brake pipe reductions made, when handling the empty and load brake train, shows that a higher speed, and therefore greater capacity of load, can be secured and at the same time a greater factor of safety in operation afforded by the use of the empty and load brake equipment. Furthermore the speed of the train without empty and load brakes varied between a minimum of 8 miles per hour and a maximum of 21 miles per hour, indicating (also when considered in connection with the brake pipe reductions required and the impossibility of fully recharging between reductions) that the brakes on this train were being taxed to their ultimate capacity. The speed of the train having 30 empty and load equipments varied between a minimum of 15 miles per hour and a maximum of 24 miles per hour, an overall variation of only 9 miles per hour instead of 13 miles per hour with the other train.

Just preceding the final application at the foot of the grade with the train having all single capacity brakes, the brake pipe pressure was only 78 lb. instead of 91 lb., as it was to start with. With the similar train having 30 empty and load equipments on the head end, the brake pipe pressure preceding each successive application was maintained at 93 lb., no difference being noticed between the recharged pressure previous to the first application and that just before the stop at the foot of the grade.

With both the 90 and 100-car trains having empty and load equipments, there was an average reserve braking force available at all times during the descent of the grade, such that at any time the forces being employed might have been increased from 35 to 55 per cent, as occasion demanded. On the other hand, the train without empty and load equipment was being taxed to its capacity throughout the descent of the grade.

The following comparison of brake valve manipulation illustrates the additional capacity and economy of the empty and load brake equipment from the standpoint of brake manipulation alone:

No. Cars (all loaded) in Train	Kind of Eqpt.	Application and Lap Pos.	Full Release Position	Running Position
90.....	90 KD	63 Sec.	65 Sec.	32 Sec.
	No E. & L.	(39%)	(41%)	(20%)
90.....	60 KD	44 Sec.	37 Sec.	71 Sec.
	30 E. & L.	(29%)	(24%)	(47%)

( ) = Percentage of total time of descent.

The longer time spent in application and lap position with the train not having empty and load equipment, indicates the longer time the brakes had to be held applied in order to get the train under control.

The longer time in release position shows the increased difficulty of recharging the train not having empty and load brakes, due to the greater depletion of the system by the severe reductions made. This also necessarily involves more unavoidable overcharging at the head end of such a train.

The fact that more than twice as long a time was spent in running position with the empty and load train than was possible with the other train shows the increased braking reserve in the greater time available in which to fully and uniformly recharge the entire system.

From the foregoing it follows that the train with empty and load equipments was much more economical in the use of compressed air. (*Proceedings, St. Louis Railway Club*, vol. 20, no. 10, p. 221, February 11, 1916, 60 pp., 16 figs. *deA.*)

Steam Engineering

STEAM TURBINE BLADE FASTENINGS, Jas. A. Capstaff

Data of tests of the comparative strength of Vickers-Ferranti, Brown-Boveri, and Lovekin methods of turbine blade fastening.

The various types of blades tested are shown in Fig. 9. In

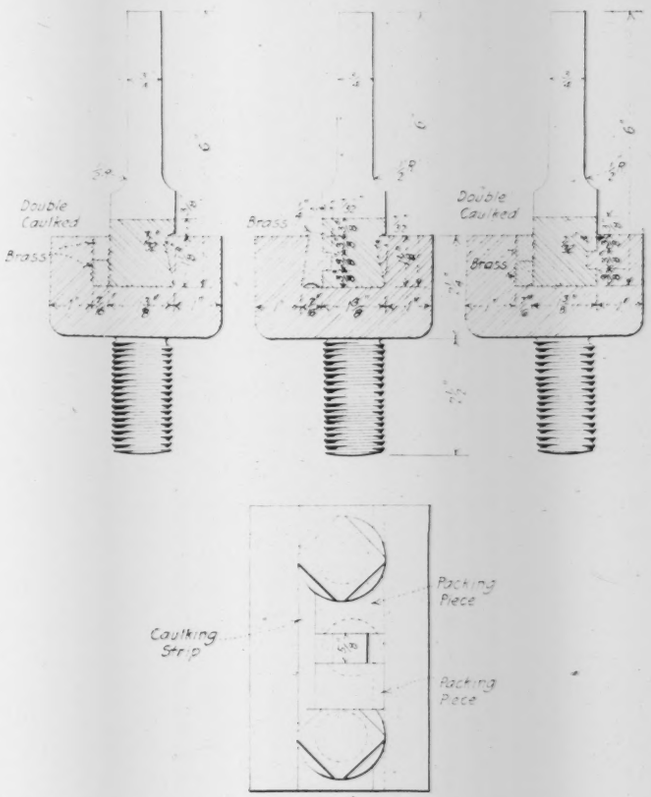


FIG. 9 VICKERS-FERRANTI, LOVEKIN, AND BROWN-BOVERI TURBINE BLADE FASTENINGS

all cases the blades were of mild steel of the same dimensions and the caulking strips were of brass. The same distance pieces and holder stops were used. The holders were similar, the only difference being the method of securing the blades.

In the Vickers-Ferranti test, a load of 10,700 lb. was required to pull the blade out of the holder. In the Lovekin and Brown-Boveri tests, loads of 17,300 and 11,100 lb., respectively, were required to produce the same result, which shows that the Lovekin blade fastening is 61.5 per cent stronger than the Ferranti method, and 56 per cent stronger than the Brown-Boveri method.

The writer also made up a test piece of the Lovekin method applied to a 250-B standard Parsons blade which withstood a load of 1900 lb., thus proving that the Lovekin method is 52 per cent stronger than the Parsons.

Brass expands more than steel or iron; therefore, any

method of blading, where brass is used, that has the distance pieces caulked tightly into grooves or projections in the adjoining blades, must form a continuous ring of brass within the groove on the steel rotor or the iron casing. If, however, the groove is completely filled and heat applied, the brass ring must expand, and inasmuch as there is no room left between the blades and distance pieces for expansion, the compression of the metal must necessarily force the blading outward and thereby reduce the clearance between the blade tips and the rotor casing. This is likely to cause blade stripping, or, at least, rubbing.

The Lovekin method avoids this trouble, as the space left between the blades and distance pieces is ample for the increased expansion. It further permits of a uniform spacing and absolute radial alinement of blades around the entire circumference and avoids large gaps or openings between the final blades. (*Journal of the American Society of Naval Engineers*, vol. 28, no. 1, p. 55, February 1916. 6 pp., 12 figs. *edc.*)

U. S. S. NEVADA PROPELLING MACHINERY AND AUXILIARY EQUIPMENT, Lieutenant Ormond L. Cox, U. S. N.

Description and trials of the U. S. S. *Nevada*, a sister ship of the *Oklahoma*. The article gives a general description of the hull, batteries, and propelling machinery with its auxiliary mechanical equipment. Only some features of its machinery are reported in this abstract.

All blades and distance pieces of the turbines are of rolled brass dove-tailed into grooves in the periphery of the wheels and drums. Intermediate blades are made of the same material and secured in the same manner to the holders. The shrouding is of rolled brass.

The forced lubrication installation in each forward engine room consists of two forced lubrication pumps, one oil-cooler circulating pump, one 250 gal. drain tank, one oil-settling tank fitted with steam coils, and one 1000 gal. oil-storage tank with necessary piping and fittings. Cooling water for the oil-cooler is supplied by the oil cooler circulating water pump or by a cross connection from the water service. The following data are given for one oil cooler:

Type	Reilly, vertical, multicoil
Number of passes of oil	3
Diameter, inside, in.	40
Length overall, ft. and in.	4-10
Coils, number	36
" diameter, outside, in.	1
" thickness, inch	0.065
" cooling surface, sq. ft.	221.4
Diameter, inlet and outlet, water, in.	03
" " " " oil, in.	03

(*Journal of the American Society of Naval Engineers*, vol. 28, no. 1, p. 20, February 1916. 35 pp., 8 figs. *d.*)

CHARTS

CONE-PULLEY SPEED TABLE. *American Machinist*, vol. 44, no. 9, March 2, 1916, ½ p.

GRAPHICAL DETERMINATION OF PARTICULARS FOR SPIRAL SPRINGS, Arthur Hoare, *Marine Engineering*, vol. 21, no. 3, March 1916, 2 pp., 2 figs.

ALIGNMENT CHARTS FOR DESIGN OF FLAT PLATES-1. Axel K. Pedersen, *American Machinist*, vol. 44, no. 9, March 2, 1916, 6¼ pp.

1. Alignment chart for design of flat elliptical plates, uniformly loaded and either supported or fixed at the edge.

2. Alignment chart for design of flat elliptical plates supported at the edge and loaded with a concentrated load at the center.

3. Alignment chart for design of flat circular plate supported at edge with total load uniformly distributed on a concentric, circular area.

4. Alignment chart for design of flat rectangular plates uniformly loaded and either supported or fixed at the edges.

5. Alignment chart for design of flat rectangular plates uniformly loaded, fixed along shorter edges, supported along longer edges.

CAPACITY OF FANS WITH TAPERING PLANE BLADES. *The Horseless Age*, vol. 37, no. 7, April 1, 1916.

DATA ON WEIGHT AND COST OF METAL IN BRIDGE STRUCTURES.

Fig. 1. Weight of Double-Track, Through, Pin-connected, Petittruss Spans of Carbon Steel and Nickel Steel.

Fig. 2. Weights of Double-Track, Through, Pin-connected, Cantilever Bridges of Carbon Steel and Nickel Steel.

Figs. 3 and 4. Comparative Costs of Double-track, Through, Riveted, Pratt-truss Spans of Carbon Steel and Mixed Nickel and Carbon Steels.

Figs. 5 and 6. Comparative costs of Double-track, Through, Pin-connected, Cantilever Bridges of Carbon Steel and Mixed Nickel and Carbon Steels.

Fig. 7. Probable Weights of Very-long-span Cantilever Bridges of Carbon Steel and Nickel Steel.

Fig. 8. Weight of Metal Per Lineal Meter of Simple-span, Double-track Bridge.

Fig. 9. Weight of Metal Per Lineal Meter of Double-track Cantilever Bridge.

Fig. 10. Cost of Metal Per Lineal Meter for Simple-span, Double-track Bridge.

Fig. 11. Cost of Metal Per Lineal Meter for Cantilever Double-track Bridge.

Fig. 12. Total Weight of Metal Per Lineal Foot of Span for Double-track, Simple-span Bridges of Carbon Steel and Alloy Steels of Different Elastic Limits.

Fig. 13. Total Weight of Metal Per Lineal Foot of Span for Double-track, Cantilever Bridges of Carbon Steel and Alloy Steels of Different Elastic Limits.

Fig. 14. Comparative Costs of Double-track, Simple-span Railway Bridges of Carbon Steel and Mixed Alloy and Carbon Steels for E-80,000 lbs.

Fig. 15. Comparative Costs of Double-track, Cantilever Railway Bridges of Carbon Steel and Mixed Alloy and Carbon Steels for E-80,000 lbs.

Fig. 16. Comparative Costs of Double-track, Simple-span Railway Bridges of Carbon Steel and Mixed Alloy and Carbon Steels, Contrasting Vanadium and Nickel Steels.

Fig. 17. Comparative Costs of Double-track, Cantilever Railway Bridges of Carbon Steel and Mixed Alloy and Carbon Steels, Contrasting Vanadium and Nickel Steels.

The Polytechnic, vol. 32, no. 6, March 1, 1916.

FLOW OF STEAM IN PIPES, W. L. Durand, *Power*, vol. 43, no. 10, March 7, 1916.

Chart: Curves by which if any three variables are known the fourth can be found.

ALLIS-CHALMERS CENTRIFUGAL PUMPS. *Practical Engineer*, vol. 20, no. 8, April 15, 1916.

Charts: Lengths of pipe subtending angles, Section 1.

Efficiencies and savings of various thicknesses of 85 per cent magnesia covering—McMillan.

Lengths of pipe subtending angles, Section 3.

Diagram for calculating offset pipe bends.

Lengths of pipe subtending angles, Section 2.

Net savings at various thicknesses of 85 per cent magnesia covering for steam at $0.10 and $0.20 per 1000 lb.—McMillan.

SELECTED TITLES OF ENGINEERING ARTICLES

AERONAUTICS

The Washington Navy Yard Wind Tunnel. Scientific American Supplement, vol. 81, no. 2101, April 8, 1916, ¾ p., 2 figs.

The M. F. P. Steel Warplane. Aerial Age Weekly, vol. 3, no. 3, April 3, 1916, 2 pp.

Testing Aeroplane Motors with a Fan Dynamometer, Lawrence Hodgson. The Automobile, vol. 34, no. 14, April 6, 1916, 3 pp., 3 figs.

Van Blerck "Twin Six" Aeronautical Motor, Model F-12. Aerial Age Weekly, vol. 3, no. 3, April 3, 1916. 2 pp., illustrated.

Envol sur place et atterrissage des aéroplanes. L'Aérophile, vol. 24, no. 3-4, Feb. 1-15, 1916, 2 pp.

Rising and landing of aeroplanes.

L'Etat actual de l'Aérodynamique, L. Marchis. L'Aérophile, vol. 24, no. 3-4, Feb. 1-15, 1916, 5½ pp.

Present state of aerodynamics

Notes on the Dimensional Theory of Wind Tunnel Experiments, Edgar Buckingham. Aerial Age Weekly, vol. 3, no. 5, April 17, 1916, 2 pp.

AIR MACHINERY

High-Speed Air-Compressors for Mining Work, J. M. Walshe. Transactions of the Institution of Mining Engineers, vol. 51, no. 1, March, 1916, 33 pp., 6 figs.

Untersuchung eines schnellaufenden Schwefligsäure-kompressors bei "trockenem" und "nassem" Kompressorgang. W. Koeniger. Zeitschrift für die Gesamte Kälte-Industrie, vol. 23, no. 2, Feb., 1916, 2 pp.

Testing of a high-speed sulphurous acid compressor in "dry" and "wet" action.

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Cracking of Barrel Sheets, Where They Crack as Well as the Shape of the Crack, Paper-Master Boiler Makers' Association Convention, Cleveland, May 23-26, 1916.

Report on the Destructive Action of Sea Water on Concrete and Methods of Guarding Against it, W. Watters Pagon. Monthly Journal of The Engineers' Club of Baltimore, vol. 5, no. 9, April, 1916, 6 pp., 8 figs.

Peculiar Appearance of Some Sawn Bars. The Blast Furnace and Steel Plant, vol. 50, no. 4, April, 1916, 1½ pp., 3 figs.

Recent Developments in the Study of Corrosion of Concrete Buildings and Pipe Lines, Morgan B. Smith, A. S. R. E. Journal, vol. 2, no. 5, March, 1916. 16 pp., 14 figs.

Gefügelehre, Eisen und Metall-Legierungen, G. Lindner. Zeits des Vereines deutcher Ingenieure, vol. 60, no. 6, Jan. 29, 1916, 6½ pp., 1 fig.

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Influence of heat treatment on physical properties (tenacity, hardness and grain structure) of iron low in carbon.

The Action of Mild Steel Under Combined Stress, Albert John Becker. The Quarterly Journal of the University of North Dakota, vol. 6, no. 3, April, 1916, 11½ pp.

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FUEL AND FIRING

Producer Gas Power from Northwestern Coals, H. V. Carpenter. Journal of Electricity, vol. 36, no. 14, April 1, 1916, 1 p.

Flame Length as Factor of Gas Burning, Frederick Peiter. The Blast Furnace and Steel Plant, vol. 50, no. 4, April, 1916, 5 pp., 14 figs.

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Application of peat firing on State railways in Sweden.

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HOISTING AND CONVEYING

Crane Handling for Sheet Mill Products, Charles C. Lynde. The Blast Furnace and Steel Plant, vol. 50, no. 4, April, 1916, 5 pp., 7 figs.

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Description of some modern installations where electric winches are used for delivering fuel to boilers.

Die Hebezeuge an der Schweiz Landesausstellung Bern 1914, Hans Krapf. Schweizeriche Bauzeitung, vol. 67, no. 12, March 18, 1916, 3¾ pp., 9 figs.

Hoisting machinery at the Swiss Exposition of 1914.

HYDRAULICS

Grouting or Cushioning Standpipe Bases, Charles W. Sherman, Journal of the New England Water Works Association, vol. 30, no. 1, March, 1916. 3 pp.

Leakage from Lead Joints in Cast-Iron Water Pipes, Arthur H. Smith, Journal of the New England Water Works Association, vol. 30, no. 1, March, 1916, 8 pp., 1 fig.

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INTERNAL COMBUSTION ENGINEERING

Operating Characteristics of Gas Producers, Franz Denk, The Blast Furnace and Steel Plant, vol. 50, no. 4, April, 1916, 2 pp., 2 figs.

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